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PROGRESS REPORT FOR 1933

ON ENGINEERING EXPERIMENTS CONDUCTED AT THE

PACIFIC NORTHWEST SOIL EROSION AND VOISTURE CONSERVATION

EXPERIMENT STATION

by

P. C. McGrew, Agricultural Engineer

ACCOBIND FOLDER

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UNITED STATES DEPARTMENT OF AGRICULTURE

Bureau of Agricultural Engineering

S. H. McCrory, Chief

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The work of the station is conducted by the Bureau of Chemistry and Soils and the Bureau of Agricultural Engineering of the United States Department of Agriculture in cooperation with the State College of Washington.

by

P. C. McGrew, Agricultural Engineer Pullman, Washington May 12, 1934

Prepared under the direction of C. E. Ramser, Senior Drainage Engineer, and Lewis A. Jones, Chief, Division of Drainage and Erosion Control Bureau of Agricultural Engineering RII gol

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early all fields now have low producing areas, where the subsoil has been exposed by erosion and, as the sell at those places till not radily absorb the rainful, there has been a increase in runoff and arosion. The contour man of Fig. 1 shows the 202 acre at thou and on the area are four hills, all under cultivation, where the last slope is 50 per cent on the attempt part. This farm is typical of the region as there are many 50 per cent alones under cultivation; in root, only a few has an found dich are act in cultivation. In Figures 2, 3, and 4 are no migrate around fields, illustrating the types a createn according in the many 50 per cent also tillustrating the types a createn according in the many 50 per cent.

WEATHER RECORDS

recording games at the station are used to ent in records of the reinfell, temperature, humidity and burn tric pressure. Delly reclimes are made of maximum and minimum temperature. Accords of wind a locate and numerical are recorded at the state College of sanington about four riles from the iteration and these records can be obtained at my time. In our un expected control the rainfall and temperature records appear to the rain of the Character. The rainfall record is used directly to concare the rain of the Character is very a eful for reference in marking a rain of the state of the area on the sanother the

only because of betwee marketess of whom and better tillers mothodus carriers and itselds now have less promicing areas, where the subscill has been exposed by erasion and, as the sail at these places will not an ally chapet the remail, there has been an ascream in runnif and crossion. The comfour and of this, I shows the See nors station and on tide area are four billes, all ander cliticables, where the land elegs is of pur next on the stoopest part. This farm is tylical of the region of those are cong 30 per cent

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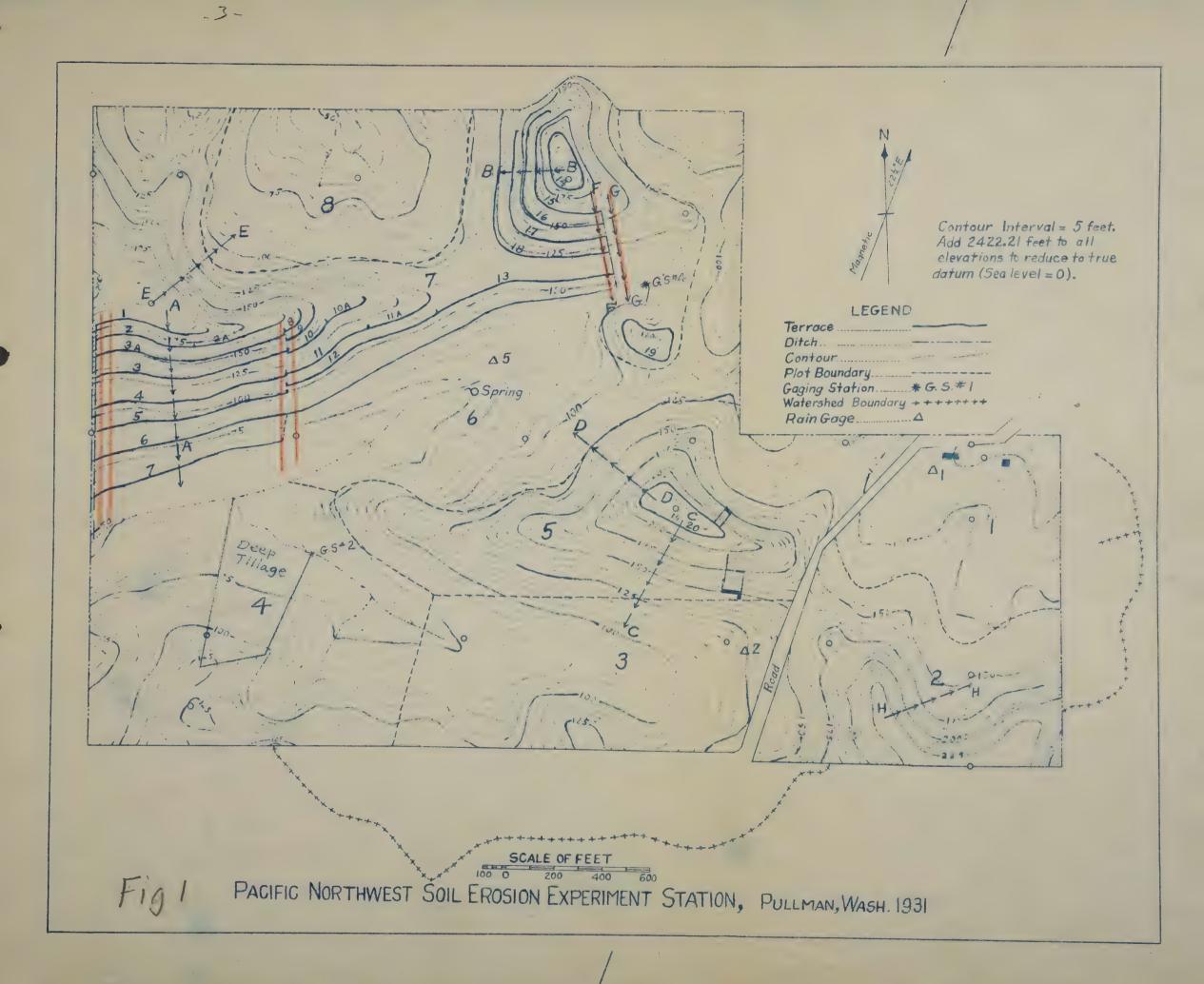








Fig. 2 (a) One season's erosion left a soil deposit 12 to 15 inches deep nearly burying a disk left in a field near Colton, Washington (b) Same soil deposit as (a) looking toward hills from which the soil was eroded. Crop was winter wheat planted on fallow.







Fig. 3 (a) Erosion on a typical field near Diamond, Washington.

Every acre of this land is under cultivation and was in a crop of winter wheat at the time this erosion occurred.

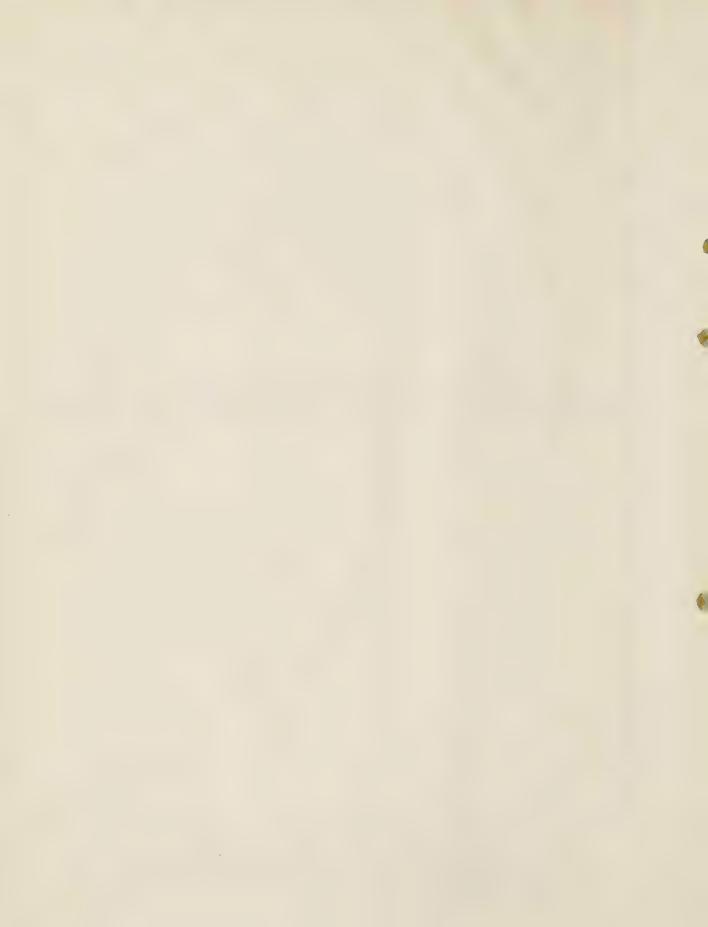
(b) Eroded field near Waits burg, Washington. These gullies were seeded across in the fall.







Fig. 4 (a) Erosion in field near Palouse, Washington (b) Gully erosion near Dayton, Washington. (Photographs by A. L. Hafenrichter, Soil Erosion Service)



water usually freezes in the flume first causing a backing up of the water which will show on the chart is an increased head. If the temperature chart shows a freezing temperature about the time there is an increased head, it is also that the increased head is loss to freezing, but if the temperature coes up or a light rain falls with the temperature above freezing, the increase in herd is known to be an actual increase in rune for this is freezing; the chart is by actual field inspection, but this is not always fractical as the conditions described occur day after day and usually at hight.

on the stoop slayer of the glouse region it is ifficult to locate rain fages where they will not be offerted by the topography. In order to check this flate, grad were a billish dat low all is utions on the farm. The los tions of rescriber were " and 5 and standard are to. 1 are shown on the rap of Figure 1. Core "c. 5 is believed to be in the best location. Also are es were located on a 30 per cent sout slove west of the plot setup. (ther seres have since been established on the hilltop insider Terrace 20 and on the 48 per cent north slope of the second for notion. Same No. 4 on the sonth clays is a characterial age and Go to be to setting a few feet to one side is of a standard type set vertically a traffice secrial ter out to a 30 per cent angle corresponding to the clore. The cor's of those & es are as follows: 医西盖子 2.45 8. . S.A. \$ 25

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-	Recording	Recording	Standard	Standard	Gage No.6	Gage No.3	Official record
		Gage No.2				on hill	at State College
1933	July Was Li	re. moli. back		on 30% S.	to 30% on 30%	inside	of Washington
				slope	S. slope	Ter. 20	
Jan.	4.56	4.43	4.61	4.26	4.57	4.30	4.49
Feb.	2.80	2.76	2.85	2.70	2.82	2.66	3.15
Mar.	1.89	1.84	1.92	1.80	1.96	1.73	1.84
Apr.	.60	•56	.72	.61	•60	.47	.70
May	91 g . 91 vy	199 .85 7	1.09	.97	-89	.79	•85
June	1.07	1.01	1.19	1.08	1.08	.91	•89
July	.25	.22	.30	.26	.20	.19	•30
Aug.	.47	•48	.51	.43	•45	• •50	•60
Sept	1.65	1.55	1.90	1.73	1.60	1.26	1.55
Oct.	4.41	4.40	4.54	4.37	4.36	4.08	3.46
Nov.	1.73	1.66	1.73	1.71	1.75	1.67	1.67
Dec.	8.43	8.23	9.24	7.76	9.13	7.46	7.12
Tota.	1 28.77	27,39	30.60	27,68	29.41	26.02	26.62

locations of gages as all gages were moved October 25, 1931. The original locations were established soon after the station was established and before any experimental work was planned. Gages Nos. 1 and 5 were only a few feet apart before being moved and both checked closely to No. 2. The 1931 rainfall at the Brosion Farm was about 12 inches less than the official station at the College, while in 1932 and 1933 the rainfall at the Brosion Farm was about 2 inches more. There appears to be considerable local variation and longer time records are needed before drawing conclusions. The College rain gage is on top of a three story building and they are planning to check the records with a second gage to be installed at another location.

Recording gages Nos. 5 and 2 check rather closely for most rains.

No. 2 recording .24 inches higher in 1932 and No. 5 recording .78 inches higher in 1933. Standard Gage No. 1 recorded about 1.0 inch higher than the others in 1932 and 2.2 inches higher in 1933. The rainfall appears to be

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Wo. 2 recording .24 inches higher in 1932 and No. 5 recording .78 inches higher in 1933. Standard Gage No. 1 recorded about 1.0 inch higher than the

others in 1935 and 2.2 inches higher in 1933. The rainfall appears to be

consistently higher for Gage No. 1. Standard Gage No. 4 on a 30% slope recorded below gages 1, 2, and 5 almost every month while special gage No. 6 with the top cut to a 30 per cent angle corresponding to the slope, recorded fairly close to the standard gages in the better locations.

Standard Gage No. 3 on the hilltop inside terrace 20 registered consistently lower than gages Nos. 2 and 5.

The snowfall is measured at several locations by use of snow boards about 1 x 3 feet. The depths are first measured with a rule to determine the average depth and after determining the average depth, a column of snow is cut out by inverting a standard rain game, pushing it down to the board and sliding a piece of tim over the opening so that the game can be lifted without the snow falling out. The snow is nelted and measured in a standard brass tube. The snowfall is recorded the same for all games and for this reason the monthly totals are rather close for some winter months when there is considerable snowfall. Records have been kept of the snow in the games with the funnel tops removed but these vary as such as 100 to 500 per cent in some cases and are nearly always considerably less than the actual snowfall.

Rains of High Intensity: The rates of rainfall in general are low as shown in Table 10. However, rains of high intensity do occur sometimes in local areas although no such rains have occurred at the College since the recording gage was installed 21 years and. One such rain occurred on July 30, 1931, as reported in the 1931 Annual Report and in more detail in State College of ashington Bulletin No. 271--"Erosive Effects of Heavy Summer Rains in Southerstern ashington," by a. A. Rockie and 1. C. McGrew.

Corer than gages Nose 2 and 5.

is the setual answirell is recorded the sense for all game and for this the gages with the funnel tops removed but these very as much as 100 to 500 per cent in some cases and are nearly always considerably less than the actual answirell.

in local areas although no such rains have occurred at the Collars aiment the recording mase was installed 21 years and. One such rain occurred on July 30, 1931, as reported in the 1931 handal Resert and in more detail.

The rain of high intensity covered an area of about 50 square miles approximately 11 miles west and 3 miles north of the Erosion Station.

A similar rain occurred the afternoon of Saptember 9, 1932, over an area of 15 to 20 square miles centering three to four miles east of the Erosion Station. The rainfall at the Station was .21 inches while a rain of two to three inches in 12 hours fell three miles distant. The rain was accompanied by hail to a depth of shout one inch over part of the area. The morning after the rain a trip was made through the area and records obtained of the amount of rainfall. These measurements were rade by the writer wherever containers were found which were known to have been empty the previous day. The containers were measured accurately and readings corrected in case the bottom is smaller than the top. The results are as follows:

Rain on Afternoon; September 9, 1933. Among Podensen Labor.

Chris Stairwald farm--3.1 inch in 29% x 56% inch vat. Rain lasted a little over an hour--one inch of hail, some still being on ground at 10 A.M. Sept. 10.

Nelson farm--2.7 inches (average of two measurements about 300 feet apart.)

Frice Tate farm--2.5 inches--average of two buckets.

Carl King farm--1.8 inches in bucket--not much hail.

Fritchard farm--1.0 inch--rain much less and not much runoff.

D. H. Vanderpool farm--.75 inch--no runoff.

The area of heavy rain was partly in the 26.1 square mile watershed of Gaging Station 7. The channel had been dry for some weeks and the runoff came down the channel in almost a wall of water. The water at the head appeared to be about a foot deep and back a few feet was two to three feet deep. Runoff samples were taken as follows:

The rain of high intensity covered an area of the bout 50 squere miles.

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an area of 15 to 20 square miles centering three to from miles east of

ages of wheeled pater soon risk word Blat street early in the Arribe.

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The morning after the rain a trip wes made through the area and records obtained of the amount of rainfall. These messuroments fore rade by the

the previous day. The containers were recoured accurately and readings or rectad in case the bottom is smaller than the tor. Ine results are no as

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sairwald forme--3.1 inch in 29; x 56; inch vot. Rein leaved
little over an hour--one test of ground et 10 A.K. Sept. 10.
"Alson farm -7.7 Littles tastes of two mousture

eteries Tate Parme-2.5 inches-average of two buckets.

. . Van derpool farm--.75 inch--no renoif.

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							charge in		
Date	of I	Rain	Date	Tire	of day	cu.	ft/sec.	% by	y weight
Sept.	9, 19	33	Sept.	9 5:2	5 F.W.	He	ad water	(0.05
68	99	M		5:3	0 P.M.	11 9 1 12	255	10.	7196
69	187 TET	A 250	Francis March	% v 524	0 P.M.		308		5.74
56	15	44	19 1	6:3	5 P.M.		360		3.54
							920(max)		
99	99	002		8:1	O P.M.		480	2	2.25
607 t	14 10 A	10 g	100 70 10				135		1.99
68	88	19	Sept.1	8:5	5 A.M.		4		•59
							•5		.16

There was runoff from only shout one-third of the drainage area and yet the maximum discharge at the gage was almost as large as for any runoff recorded. The soil content in runoff water was the highest ever recorded and the soil losses averaged .57 tons per scre for the entire watershed and were many times this amount on some of the fields.

on the same afternoon three other rains of a similar nature occurred at other points in Eastern Washington-one between lalouse and Colfax, one near Garfield, and one near Tekoa. Two of the areas were inspected and the erosion appeared somewhat less than for the area near the Prosion Station.

In the area of most intense rain, runoff occurred from all sloping land regardless of cover although there was no noticeable soil losses from standing wheat stutble, grass, or alfalfa. The heavy soil losses were from fallow land, land which had been in pers and any land not covered by vegetation.

Although these summer rains are spectacular in their results, they are infrequent and are a minor problem as compared to the sheet washing

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In the area of most intense rain, remoff occurred from all sleping

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which occurs day after day nearly every winter over the most productive wheat land of Eastern Washington and adjoining portions of Idaho and Oregon.

Weather Conditions As Affecting Erosien and Runoff: The erosion during the past three years varied considerably due to veristions in rainfall, snow, and temperatures. The daily rainfall records for 1933 are given in Table No. 1 and Fig. 5. The rainfall for 1931 was below normal and for 1932 and 1933 was above normal, the monthly totals and U. S. Weather Bureau normal being as follows:

	Normal U. S.	Gage 1	vo. 5 on Eres	ion Station
Month	Weather Euroaul	1931	1932	1933
January	2.70	2.22	3.26	4.56
February 🥂	1.2% 2.09 This is, i	1.42	2.92 3. 4	2.80
March	2.07	3.91	4.50	1.89
April	1.50	1.09	1.28	•60
May	1.57	•50	1.96	.91
June :	1.26	1.30	.26	1.07
July	•52	•05	.77	•25
lugust	.63	0	.15	.47
September	1.23	.78	.13	1.65
october	1.51	1.84	2.29	4.41
November	2.97	2.35	4.44	1.73
)ecember	2.68	3.06	2.42	8.43
rotal	20.73	18.52	24.38	28.77

1. U. S. Werther Eureau records kept at State College since 1893.

The general weather conditions during the different years were as follows:

October to December 1931 -- Precipitation was about normal but distribution and intensities were such that only a small amount of runoff occurred.

January to March 1932--Precipitation was 3.8 inches above normal.
Rapid melting of snow, and rains caused serious erosion on several days
during this period.

October to December 1932 -- The precipitation was 2.0 inches above

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OANE May 5 Near Conter Farm TABLE [. HALNWALL AT EXCOSION STATION FOR 1933

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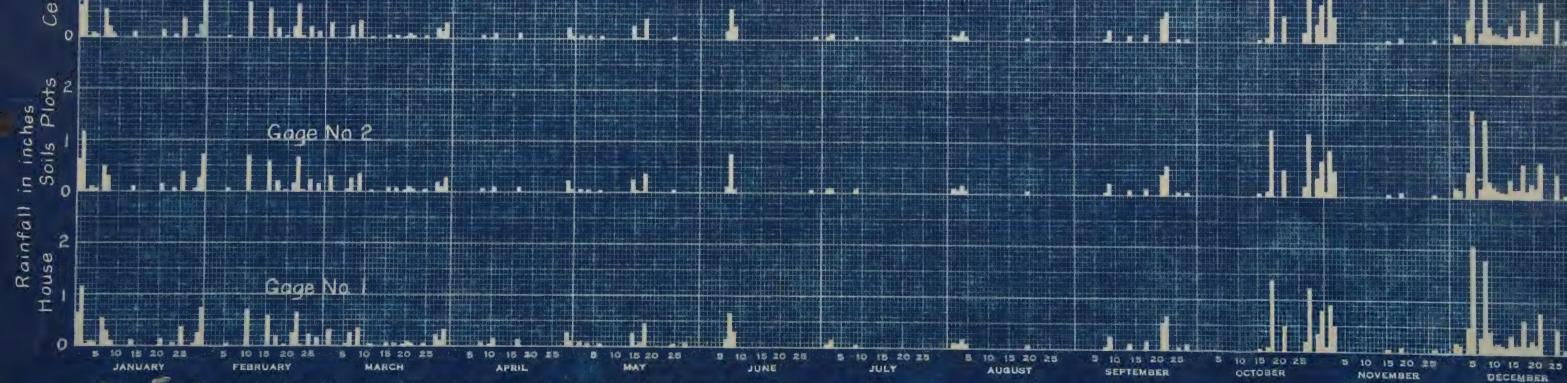


Fig. 5 Record of daily percipitation on the Pacific Northwest Soil Erosion Experiment Farm for the year, 1933



normal, most of the excess being during November. The runoff during November was from rain on unfrozen ground, while the December runoff was caused by melting snew with the ground frozen.

January to March 1933 -- The precipitation was 2.4 inches above normal and was characterized by heavy snow and freezing temperatures during the latter part of January and most of February. Runoff and erosion were heavy in early January and again in late February and early March.

normal, 5.7 inches of the excess coming in December. There was only a smell abount of snow and the ground was not frezen except for a light crust on a few occasions. Not much resolf occurred in October and November but the runoff and soil lesses were heavy in December. The runoff was due to main on unfrezen ground in excess of the absorptive capacity of the soil.

the yearly distribution of rainfall at sullman shows a normal of below 1.6 inches each month from tyril to detaler inclusive, with only .52 inches for July. The months from November to Earch each have a normal exceeding 2.6 inches, with a maximum of 2.97 for November. Thus the normal for the 7 months of April to October is 8.22 inches and for the other five months is 12.5/ inches. Lith this distribution of rainfall and practically all the rains of low intensity, the erosion problem becomes essentially a winter erosion problem, usually starting in November and ending in Earch. The rainfall during the winter access, although low in intensity, seturates the soil and runoff with seriou erosion results. For example, in December 1933, there was rain every tay but one for the

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normal, most of the excess being during Powenber. The runoff during November was from rain on unfrozen ground, while the December runoff was caused by melting anew with the ground frezer.

January to March 1933--The precipitation was 2.4 inches above normal and was characterized by heavy snow and freezing temperatures during the latter part of January and most of February. Eumoff and erosion were heavy in certly January and again in late February and early March.

October to december 193-The precipitation was 7.4 inches above dermal, 5.7 inches of the excess coming in December. There was only a small abount of snow and the ground was not frezen except for a light crust on a few occasions. Not much runoff occurred in October and Movember but the runoff and coil leaves were heavy in December. The runoff was due to main on unfrezen ground in excess of the absorptive capacity of the soil.

The yearly distribution of reinfall at influences as normal of ledow lob inches each menth from April to October inclusive, with only .52 inches for July. The months from Movement to Herch each have a normal exceeding 2.6 inches, with a maximum of 2.97 for November. Thus the normal for the 7 months of April to October is 8.22 inches end for the other five mentic is 12.57 inches. With this distribution of rainfall and practically all the raiss of low intensity, the erosion problem becomes essentially a winter erosion roblem, usually starting in Movember and ending in forch. The rainfall during the rinver assens, although low in intensity, setumates the soil and runs? With serious erosion results. For intensity, astumates the soil and runs? With serious erosion results. For example, in Oceaber 1933, there was rain every 'my but one for the

eightsen days from December 5 to 22, the total being 7.53 inches and on the last day of this period, a rain of .79 inches fell with the highest intensity so far recorded for the Station. This rain caused serious soil losses as shown in Tables 10 to 14.

The rainfall increases slightly to the east of Julicon and decreases to the west to less than eight inches near the Columbia diver. The erosion is less where the rainfall is less, although it may not be a direct propertion. It the adams Branch Substation of the State College of Washington the ave age annual rainfall since 1916 has been slightly below eight inches. During the last four years, with rainfall below normal, there has been one year with no ramoff, but serious ranoff and erosion occurred the other three years. However, the water erosion in this area of low rainfall is less serious than the wind erosion.

LAXIMUM RATES OF RAISHVIL AND JUNET

The rates of rainfall and runoff for 1933 are given for each terrace and water shed in Tables 10 to 14. The rates of runoff are not always in proportion to the rainfall or size of watershed but in some cases depend on the distribution of snow. Some of the outstanding days for the years of 1932 and 1933 are grouped for convenience in comparing the different terraces and watersheds as follows:

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eighteen days from December 5 to 22, the total being 7.53 inches and on the last day of this period, a rain of .79 inches fell with the nighest intensity so far recorded for the station. This rain caused serious soil losses as shown in Tables 10 to 14.

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The rates of rainfall and ranel for 1935 are given for each terrace and w ter shed in Tables 10 to 14. The rates of rane 1 are not always in proportion to the rainfall or sive of raterahed has in some eracs lapend on the distribution of snow. Jone of the outstanding eags for the years of 1932 and 1932 are grouped for convenience in comparing the different terraces and watershide as follower.

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Tera 3A Trans	1.04 - 003	ing the store	3 - 12.51 .	.054	.067	*267	-410
Tor. 3	1.22	.0231	.277 ¹	.041	.015	.300	.471
Ter.4	1.85	.008	·320 ²	.051	.007	.166	.241
Ter. 5	1.26	.014	.273	•039	0	.126	.181
Ter. 6	4.68	•008	.205	•052	.021	.104	.114
Ter. 7	2.09	•038	.072	•105	.138	0	•076
Ter. 13: 10:	700-1.5215	त्ति है 🐞 भारते 🦻	Topic to mit	.021	•039	•124	. 124
Ter. 15	•89	-	-	•054	.089	*602	.813
Ter. 16	.82	.080	.219	.021	.037	•472	.€05
Ter. 17	•92	Trace	.276	-017	*003	.517	-625
Ter. 18	1.18	Trace	.200	•030	•003	.261	.261
G.S. 2	68.2	.247	•166	•040	•175	•077	.118
G.S. 4 8" 18"	2.33		4302 C	-085	.136	.421	•472
G.S. 5	14.4	100	-	•046	.103	•003	•027
G.S. 6 The	Track 15.2 Fair	fall rates	१८५ 🗢 १८४३	•030	.052	*389	- 269
G.3. 7	16704.	***			.009	.024	.039

1. 35 foot vertical spacing

2. Break in Terrace 3 let water on Terrace 4.

		Ma					. Total	Maximum	
Date			(inc	ches pe	er hre)	Rain-	Total	Remarks
		5	10	15	20	30	full	Runoff	
	73.6	Min	Hin.	Min.	Min.	Win.	(inches)	(inches)	
ian. II,	1932	.33	•33	.33	.31	.30	•69	.73(0.5.2	l) hair on snow
ar. 27-28	1932	.42	.36	.32	•30	-24	•73	-75(G.S.4)Rain on snow
ec. 28,	1932	.16	-16	.16	.15	.15	.27	1.31(Ter.)	
lan. 5,	1933	100		54 MI		Call I	.07	1.64(0.8.2	Runoff from
Dec. 6,	1933	-481	.36	.32	.21	.18	1.82	1.23(G.S.4)No grow
Dec. 22.		.72	.42	.88	.21	.14	.79	.74(G.S.4	No snow

1. The maximum rate of rainfall was about 1.2 inches per our for a one minute period.

The total rainfall and maximum runoff are recorded in adjacent columns. In all but two cases the daily runoff for the station having maximum runoff exceeded the rainfall. This was caused by melting show.

On January 5, 1933, the runoff for Caging Station 2 was 1.64 inches and the rain for that day was only .07 inches. On this day the maximum rate

19,91 manufaction least to person! LAPOLAL BATTE LI 41114 L-II . LIII - 10 . SUP. -2 115 14 3 3 47.1 de 579 . 0 SIT-F------175 7 4 . TITL. 1.71 100.7 112. . E . 711 17 BET. 1 IIII. =34 1.4757 . . . a . × . MIT. o F +715 ~ . HITA. 2704 .. 4 . -77. , . --HCh. . ROTS. ar . T 0 CITU . . y -+ . 71.7 OTL. SE COL DOM: , . 3 ; . 5 . ----. , * 14 . 4 2-. . . = 4 . 2 2 . to to time Los from took at al 2. Breek in terrace 3 let witer on for ace 4. Division in Lance LANG THE EMPHANTS 24-5 10110 1 ×. A 0 TARREST . 180 Mary will . . 9 × -70 word no what Wederlie te ** m. To (6.8.4) of the on anon-. . 0 -14 wors no atch(f. ret) it. moining snew MALL AND ys. , 11. 1 12 ----I SO THE PROPERTY AND DESCRIPTION OF REAL PROPERTY AND ADDRESS OF

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The total rainfell and rainfell are recorded to relate the chitten having process of the chitten having area.

This was exceeded the rainfall. This was exceed by selting ones.

The was constant the rainfall. This was exceed by selting ones.

of runoff for Gaging Station 2 was .175 inches per hour.

On March 27-28, 1932, the maximum 5 minute rainfall rate was .42 inches per hour, which fell on ground partly covered by snow. The highest rate of runoff was for Gaging Station 4 with .302 inches per hour (not including Terrace 4 which received water from brook in Terrace 3).

The maximum rate of runoff on December 6, 1933, was .602 inches per hour for Terrace 15 which exceeds the 5 minute rainfall rate of .48 inches per hour. From an examination of the rainfall chart it appears that the rainfall rate was about 1.2 inches per hour for a one minute period which may account for the high runoff rate.

The runoff and rainfall rates on December 22, 1933, exceeded any previous records. The maximum rate of rainfall for a 5 minute period was .72 inches per hour. The maximum rate of runoff for Terrace 15 wam .813 inches per hour which exceeded the maximum rate of rainfall for a 5 minute period. This high rate maybe been caused by a higher rate of rainfall over the watersheds of Terraces 15, 16, and 17. A high wind caused some vibration of the pen on the rain rage and the rate of rainfall for less than 5 minutes cannot be read.

TERRACING STUDIES

The terraces on the Station are on a South slope varying from 12 to 32 per cent, with some terraces extending around the hill on the west slope as shown in the map of Fig. 1. A description of terraces giving grade, length, spacing, height, and width is given in Table 2.

The cropping system of wheat--Summer fallow is nost widely used in the Palouse Region and was adopted for the terraced land. The erosion

and the first the second of the first the firs Oh. are ever fighter course a maniam out about the sec. to be all the control of the control The first of the second of . It was to the first the first to the first that the first to the first the first to the first AND THE RESERVE OF THE PROPERTY OF THE PROPERT Du to all a find a low of sole it we also up table it is a war that said the inches per hour. From an examination of the rainfall chart it appears William who is the factor of the state of th perfect which may account for the high reactive source. the formal profit of which the refer that he from the profit and tour records. The maximum rate of rainfall for a 5 minute period was SID. Am All search of There is not presented and requested in attended to the second of the Committee the second of the se the property of the party of the state of th

Il most suivere equia dinos as as as as firm is the single verying the suivere equipment to make a describition of the manage of Fig. 1. A describition of themses of the suivere equipment is the suivere as a suiverse and suiverse equipment is the suiverse and suiverse equipment is the suiverse and suiverse and suiverse equipment is the suiverse and suiverse and suiverse equipment is the suiverse equipment of the suiverse equipment is the suiverse equipment

The cropping system of whest-Surmer felicw is note widely used in the lalouse Region and was shopted for the terraced land. The erasion

with this cropping system is believed to be more serious than any other furming practice, but excellent yields and weed control have made this system of farming profitable. This system cannot continue indefinitely although it can be prolonged if the erosion can be materially reduced. The cropping system of the farm is shown in Table 3, for the fields as shown in Fig. 1. This does not include the small experimental plots.

The drifting of snow introduces a problem in connection with terracing which requires study. The snow drifts senetimes form across the terrace channel and if a sudden runoff occurs, the water may breek over the terrace. This condition occurred a few times during the winters of 1931-32 and 1932-32, but did not occur during 1933-34. A few more years records are needed to determine whether this factor is important. The distribution of snew varies widely and is discussed under the terracing experiment of different land slower. The rates of runoff are low as compared to other sections of the country and the channel capacities of terraces do not need to be large.

The Parshall flume, with water stage record r, and the Ramser silt campler are used on all installations for reasuring runoff and soil losses from terraced land. These records, along with observations of ercsion, cost records, and rachinery studies are used as a basis for determining the value of terracing in erosion control

EROSION AND RUNOFF FROM GRADED TERRACES'
WITH DIFFERENT VERTICAL SPACINGS (Sub-Project No. S.E. 7.1)

The terraces included in this study are 780 feet long and are on land slopes of 20 to 28 per cent. The vertical spacings on the original

This croffing system is colleved to be more serious than any other aids sher eved forteed beet but ableiv ineflexes sud ; system of farring profitable. This evalue caused continue tadefinitely the second secon oropping spatem of the from is shown in Table 3, for the fields as when the property of the party the second of the second secon the acting which requires study. The enow drifts south to form scrose the terrace channel and if a guiden runoff occurs, the atter may break over the except of a set of the OWNER AND ADDRESS OF THE PARTY AND ADDRESS OF THE PARTY. are applicable at the state of the second are strong Secretary of rather becomes at the coats of the bar to principle. and the set of the first the selection. The selection is a resident to the selection of the to be the second and the second secon constructed have been all successi The same in the polymer with rate of the same with areast the sea there excesses established the season services process I should read the walls of these and the Language and principal and all the second principal and property and the second principal and property and the second principal and th Lordnos a E. Dedamin de

land alopes of 20 to 28 per cent. The vertical specimes on the original

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WANTE HO.2, DIMENHACKS AND DRAINAGE AREAS OF TERRANDES ON PACTIFIC MONTHACT SOIL PROBION EXPERIMENT STATION

Homarik			open end					oron one:	cloned endu	closed endu	open end	closed ends	oben end	closed ends	pue uedo	circle terrace				1. 通量的 1947 / 建设工	adrela terrana	otrele termine
Pimensions of Terraces Average Average Fidth Height		0,0	e 1	1 2		m e	1 e	• -		o,		7		1.3	20 H		7.8	1.2	1,0	71	1.0	1.0
Plennelone Average Ridth		8 8	*	di Na Ge		37	23.5	26	\$	ħ.	ā	ž.		F.	a	8	5	56	₽.	58	2	
Mangth	1007	47.5	55	<u> </u>	760	9 180	180	3	115	300	198	9 8	804	690	98	625	695	77.5	780	780	089	930
Zell Almsg Length Terrace	48./1001	44	T T T	ងឌ	er er	8	1 5	TowoI	Lovol	Ilmol	Iowal	level	lovol	Tower	lavol	level	1	16	18	•0	level	level
Avg. Variical interval Estween	ract	16.2	8.61	15.0	95.0	0.0	3.5	70.6	30.0	15,0	0.7	20.0	ты —	0.01	中田	14 m	0 A	15.5	11:1	14.0		
Averale Land elone Between Terraces	Mer dem	15.61	100		23.6	20.0	o u	14. 27	1000	1.00	15.01	28.6	- Million	30.6	15.8	34.72	24.0	26.7	28	3	10.01	10,31
Terrage Fields Brainage	Acres	20.5	i ii	£ 8	1.85	3,16	B9 0	9		eg.	12	E143		50.	1 . 13g	1	681	4	ed O	1-118	90	=
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Joseph de Marie		elija	ลี	3.A	*	in	io 1		6	9	ğ	17	TE		4	N.	9	9	11	4	10	90

1. Upper terrace. Land alope and vertical interval are average to conter of ridge above. 2. Whith measured from upper edge of cut to lower edge of fill.



CARLE 3 . CAUP ROTATION PLAN

	1940	Pomor	o swittence	poor.	minor	fe 1 Jou		av albout	1000		
	1939	pood	fellior.	Transport.	www	v. wident 15 pot:	P080	fallor	SATISTICS.		
	1928	ipomų.	D-MINORY.	fillow	fil1207	Mollow	a Tilen	Verydrand			
8	1937	b bear	falle	į	professor	w.wheat 20 pet.	Poort	fin 12 or	ivaper:		
Washingt.	1036	i de	a sheart		uswheat	fellor	a catheast	vorticut	Ė		
Pullirun,	3035		fallor	transparen	g, clover	a shant		fallow	as wheat	ផងដូន	五甲二四
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Soil Eros	1938		File	- Selfores	and a	3-valeout	16 pot-	millor		8200	닭 8 커 <u>중</u>
	2000		a. Minut		fa 11 or		Tamboat	Torneat	2	5883	284
			fa11.0m	10.100	Timper 1	fe 13 cm	Ponta L	- Fee.	Police	* 66 66	2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
		9	18	172	96	3	Q	40	36	ara s	All crops Fallow Clots, Grass, etc. All land
		ė	61	œ.		4		-	as:	Forntoes	All crops Fallow Clots, Gra

1. The cropped area is frequently less due to experimental plots being taken out.



experiment were 15, 25, and 35 feet. The erosion for the 35 feet vertical spacing was so severe that the terrace channel was almost completely filled with soil the first winter, causing overtopping several times and it was decided to construct an intermediate terrace. The measurements of soil and water losses both before and since the construction of the intermediate terrace are summarized in Table 4. A detailed record of runoff and soil loss for 1933 is given in Table 10. In comparing the results for this experiment, as shown in Table 4, it is noted that Terrace 5 with a 15 foot vertical spacing lost 1.82 tons per acre and Terrace 3A with the same spacing lost 5.11 tons. Terrace 4 with a 25 foot vertical spacing and 3 with a 20 foot spacing had soil losses of 3.03 tons per acre and 4.56 tons respectively. The water losses were in the same order as the soil losses. From an examination of the location of these terraces, as shown on the map of Fig. 1, it will be noted that the upper terrace of this group had the greatest soil loss and that each terrace below lost less soil than the one above. The fact that the soil and water losses seem to have no relation to the vertical spacing indicates that other factors have a greater influence on this particular group of terraces than the vertical spacing. These factors are believed to be the soil and land slope. According to the soil survey, the soil is progressively better and more absorptive from the upper to the lower terrace in this experiment. The crop yield of winter wheat for 1932 was taken across this group of terraces at the locations shown on the map of Figure 1. The average for the undisturbed

in the state of th protestions described the law of sevent and dold extent on the effect. filled with soil the first winter, causing overtepping several times and To please the tell parties alexanders on the transfer of believe and the soil and water losses both before and since the construction of the Autorthere is the terminal because a contract of the transmission of a contract with the the second of th Mile of the term of the control of the profile of the control of t take at exercit year over your rest to 1 feet had been insident part of a which is the state of the stat and the second of the second o ्र विश्व के अपने The second secon the map of Fig. 1, it will be noted that the unjust terrace of this group had the greatest soil loss and that each terrace below lost less soil than the one above. The fact that the soil and water lesses seem to have no relation to the vertical apacing is dicates that other factors have a greater influence on this particular group of terreces than the vertical specing. These factors are believed to be the soil and land close. According to the soil survey, the soil is progressively better and more absorptive from the upper to the lower terrace in this experiment. The crop yield of winter wheat for 1932 was taken across this group of terraces at the ALTERNATION OF THE CONTRACT OF

TABLE 4, EMOSION AND HIM-OVY RECE GRADED TESTRICES WITH DIFFERENT VERTICAL SPACINGS

	AN AND PROPERTY.		Winter wheat following pens	Ginter wheat following pene Winter wheat Winter wheat stubble	Winter wheat stubble Fallow Winter wheat		35 foot vertical apacing 20 foot vertical apacing Data for 1932 only
CTO	- F	толя	•	8 6 6 6 6 7	51 .03 0 0 1.60 1.20 5.11 1.23	5.11 1,82	ச ் ன்ள்
DOT	Tor 3A	tone		1001	,51 0 4,60 5,11	5.11	
hold four por Acre	i in	tenn	0	36.00	2.0 % %	4.563	Grede 12 12 12 12
5.03	ا- في	Lone	•	3.92 0.03 3.94	2 0 0 E	3.03	9 19 19 19
	Ter.	Inchon	٥	1.0%	.61 1.24 1.85	5.943 1.14 3.03 4.563	Length fact 780 780 780
Run-of F	Far	inches inches	9	10.1	1.42 5.83	5.94	Can to o o o o
otal	300	មកកាម	0	1.16	2.03 3.46	3,463	Verticel Specing fept 25.0 20.0 15.0
Mary Assessed	E			.95 0 .86 1,81	1.15 0 1.86 3.01	2.41	Series S
Total	Kain- fall	inches	8.03	1932 11.96 1932 5.56 1932 6.86 1932 26.38	9.25 9.36 10.16 85.77	26.58	
T 07.			1931	1932 1932 1932 1933	1933 1933 1933 1933		Drainage Aree Acres 1.85 1.09
	Forto		Sept. to Dec. 1931	Jen. to Apr. May to Oct. Mor. to Dec. Total	Jan. to Mar. Apr. to Oct. Mov. te Dac. Total	AVE. 1932-1933	In. 14 %



portion between terraces is as follows:

T	errace	Yield of	Avg. Land	Soil	Loss pe	er Acre	Vertical
	No.	Wheat	slope	1932	1933	Average	Spacing
		bu./acre	Jo	tons	tons	tons	feet
	3A	27.3 30.3	27.6	100	5.11	5.112	15
	3	30.3	27.8	4.401	4.56	4.562	20
	4	34.8	23.6	3.94	2.12	3.03	25
	5	38.6	20.0	2.41	1.23	1.82	15

1. 35 foot vertical spacing

2. Date for 1933 only

It is seen that the crop yield is inversely in proportion to the soil losses and that the yield increases progressively from the upper to the lower terraces of this experiment. The upper slope is slightly steeper than the lower slope, as shown in the table above, which would also tend to increase the soil losses for the upper terraces. A more detailed soil survey is now being made and crop yields for 1934 will be taken at definite intervals along each terrace, both on the terrace and between terraces.

In Table 4 it is noted that the ground was covered by winter wheat stubble the fall of 1932 and spring of 1933, and that the soil loss under this condition was small as compared to the loss from winter wheat following peas the winter of 1931-32 and winter wheat following summer fallow the fall of 1933. The results are summarized in the following table.

Type of Ground cover		s soil			Total Runoff in Inches				
· ·	Ter.3A	Ter.3	Ter .4	Ter.5	3A	3	4	5	
Ground cover, winter wheat stubble	.281	.02	-04	.02	1.14	.62	1.00	.60	
wheat stubble winter wheat following peas('31)& fallow(33)	4.602	4.463	2.98	1.80	4.232	2.083	1.40	1.14	

1. Losses large due to terrace being bare following construction in stubble field after harv est 1932.

2. Data for 1933 only as terrace was not constructed until fall of 1932.

3. 35 foot vertical spacing spring of 1932.

 -		-	,	100	THE DESIGNATION OF	. 1 - 120
Spacing	anaraya	ELOI	1932	squis	Jaoria .	e U ? :
 15e) 15e) 15 25 26 28	tons	tons 5.11 4.56 2.12	Loa.4	27.6 27.6 23.6	27.3 27.3 30.3 34.8	3A 3 4

1. 35 foot vertical s.

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It is seen that the crop yield is inversely in proportion to the soil

terraces of this experiment. The upper slope is slightly steeper that the the tope as shown in the tople above, which rould also tend to increase the soil losses for the upper terraces. A more detailed soil survey is now

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Inches	ni Monus Istor				lest per	TOG OTE	pe of Ground cover		
	- 1	- 8		145		1,711	11.30		
							i.		ra-bostu r mitute
AI.I	1.40	8.083	888.4	08.	1 98.8	639.P	- OC -	aner [29886]	1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
ST SOLLS	in lies	-01	0.3391		Strau a	e vrsd	refig	losses lerge stubble field Data for 1933	

3. 35 foot vertical spacing spring of 1932.

The soil loss was from 16 to over 200 times greater for wheat planted in the full on summer fallow or land which had been in peas as compared to land covered by wheat stubble.

EROSION AND RUNCFF FROM GRADUD TURRACES WITH DIFFERENT LENGTHS (Sub-Project No. S.E. 7.2)

Terraces 2, 5, and 6 having lengths of 400, 780, and 2274 feet respectively are included. The vertical spacing is approximately 15 feet and the grade is 12 inches per 100 feet for all terraces. The record of runoff and soil losses is summarized in Table 5. The detailed record for 1933 is given in Table 11. The average ennual soil loss was 1.87 tons per acre for a terrace 400 feet long, 1.82 tons for a terrace 780 feet long, and 3,94 tons for a terrace 2274 feet long. The soil loss was more than twice as great for the terrace 2274 feet leng as compared to the shorter terraces. There was more washing in the channel of the longer terrace due to a larger quantity of water. The longer terrace was on about the same soil as the terrace 780 feet long. Subsoil was exposed on parts of the watershed of Terrace 2, 400 feet long, which would tend to increase the soil losses as compared to the other two terraces. The poor soil and slightly steeper land slope for the terrace 400 feet long probably accounted for the soil losses being almost the same as for the 780 foot terrace. Soil was better and the land slope less for the terraco 2274 feet long, but these factors were overbalanced by the length of the terrace and it appears quite conclusive that the soil losses are greater for the longer terrace.

The runoff was in the same order as the soil losses, although the

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Terraces 2, 5, and 6 having lengths of 400, 780, and 2274 foot respectively are included. The vertical spacing is approximately 15 feet record of

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acre for a terrace 400 feet long, 1.82 tons for a terrace 750 feet long, and 2,94 tons for a terrace 2274 feet long. The soil loss was more than twice as great for the terrace 2274 feet long as compared to the shorter terraces. There was more wishing in the chi nol of the longer terraced no terraces. In quantity of water. The longer terrace whe on scout the same seil

as the terrace 780 feet long. Subsoil was emposed on parts of the watershed ace 2, 400 feet long, which would tend to increase the soil losses as to the other two terraces. The poor soil and slightly steeper land

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less for the terreco 2274 feet long, but these were overbalanced by the largth of the terrace and it suppers quite conclusive.

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TABLE 5, ERCS TON AND RUN-OFF TRUL DIALDED TENIACES OF DIFFERENT LENGTHS

Grado	11. 12 13 13 13
liven g (k)	Feet 400 780 2274
Vertical Specing	Feet 15.0 15.0
Lend Stope	7 2 2 2 2 7 2 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Drainngo Area	λετυα .56 1.26 4.68
Terrana No.	ன மை



difference between the 400 foot and 780 foot terraces was greater. The 400 foot terrace, having subsoil exposed in places, had 2.29 inches runoff compared to 1.74 inches for the 780 foot terrace on good soil. The runoff of 3.24 inches for the 274 foot terrace was more than for the other terraces due to more snow accumulating on the watershed of this terrace.

EROSION AND RUNOFF FROM GRADUD TERRACES WITH DIFFERENT LAND SACRES (Sub-Project No. 3.E. 7.3)

Terraces 7, 5, 17 and 3A are included in this experiment and are on land slopes of 14.5, 20.0, 23.5, and 27.6 per cent respectively. All terraces are 780 feet long and have a uniform fall of 12 inches per 100 Terrace 3A was not installed until the fall of 1932 and only 1 1/2 years records are available for this terrace. The messurements of soil and water losses are summarized in Table 6. A detailed record of results for 1933 is given in Table 12. The soil losses in general increase as the slope increases, the average annual loss being at the rate of .57 tons per acre for a 14.5 per cent slope, 1.82 tons for a 20.0 per cent slope, 7.20 tons for a 23.5 per cent slope, and 5.11 tons for a 27.6 per cent slope. There are other factors besides the degree of slope, which influence the amount of runoff and soil lesses, the soil probably being the most important. Terrace 7 on a slope of 14.5 per cent is near the foot of the slope and is on excellent soil, fairly well drained. Terrace 5 on a 20.0 per cent slope is on good soil but not quite so productive as Torrace 7. Terrace 3A and 17 are on upper slopes where the subsoil is exposed in places and the soil is much less productive. The results of the various experiments show that the soil loss from a deep productive soil is less than where the soil is thin. This statement is true only within certain

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Terraces 7, 5, 17 and 3A are included in this experiment and are ca land slopes of 14.5, 20.0, 23.5, and 27.6 per cont respectively. THE THE RESIDENCE THE THE PROPERTY OF THE PARTY OF THE PA Principal city in a supply with the last time and the second same her ther he observed our property patients affecting our alresty where THE ADDRESS THE DESIGN ASSESSED IN LABOUR THE SHEET THE SHEET THE SHEET WARRANT TO SHEET WHEN 1933 is given in Table 12. The soil losses in general increase as the way book TE, to show but to metal sund jumps necessary of appeared again acre for a 14.5 per cent slope, 1.82 tons for a 20.0 per cent slope, 7.20 tons for a 23.5 per cent slepe, and 5.11 tons for a 27.6 per cent slope. and assert buy delike page to be served not asserted product pulled and wellamount of runoff and soil losses, the soil probably being the most inportant. Terrace 7 on a slope of 14.5 per cent is near the feet of the slope and is on excellent soil, frirly well drained. Ferrace 5 on a 20.0 per cent slope is on good soil but not quite so productive as Cerrace 7. at passys and treatments who prove anythe recent to your TE you of reasons. position and in address and presentant real two styles are less assels weather from methodoxy make a ment out the add self-outs at a section as elarmo Antino gian acri el Biscaleta mist print al line nel panio cult

TABLE 6. MADSION AND RUN-OFF FROM GRADED TERRACES ON DIFFERENT LAND SLOPES

1		i		9	1			1		
Monaple			sinter wheat following pess	winter wheat following peas Winter wheat Winter whom stubble		Winter wheat stubble Fallow			Date for 1923 only	7
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) ' 2),	1	DIFF	winter wheat Winter wheat		Winter wheet Fellow feter when			ita fa	
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TONS FOR ARED	Tec.	TILL	0	5.32	200	808	9.05	7.30	0 pud 0	47./1001 12 12 13 13
12	T s	tons	0	2.39	2.41	808		3, 52		
5 min	Tur.	1 cms	۰	.7. 0. 80.	03.	808		150		
off Spil Long	Tar. 3A		0	not intelled 59		1,1	36.5	2,70 5.941	Length:	780 780 780 780
To-on	Total LV	nechan	0	1.09	1.48	15.0	10.0	2.70	Vortical Spacing	Feet 15.0 15.0 14.8
Total Hun-off	for.	Di Ching	0	1.04	1.64	ġo:	1.85	1.74	V or I	4 4 4 4 4
	į.	inches inches inches mahas	•	2.06	4.23	4.25	16.4		Land Slope	23.5 23.5 23.5 23.5
Total	Rain-	inches	8.03	11.96 5.56 6.86	# 3E	9.35	1933 28 177	86.58		
				1932 1932 1932	1932	1933	1933		T la se	Acres 2.09 1.26 1.04
			Bept. to Dec. 1931	Jan. to Apr. May to Get. Nov. to Dag.	Totali	Jan. to Mar.		Avg. 1082-1933	Terraco No.	P 21 P 42



limits, however, as the soil loss seems to decrease when the subsoil is exposed, as compared to when the soil is thin, although the per cent runoff may increase. The subsoil is exposed over a larger pert of the watershed of Terrace 3A than for Terrace 17 which may account for the smaller
soil loss from Terrace 3A even though the slope was slightly steeper. The
runoff was greater from Terrace 3A than for 17 which also would point to
the same conclusion. Detailed soil surveys are now being made and more complete crop yields for 1934 should be helpful in interpreting the results for
this experiment.

The soil loss from Terrace 7 was only .57 tons per acre and yet the average runoff was 4.60 inches which was exceeded only by Terrace 3A. From an examination of Tables 6 and 12 it will be noted that the major part of the runoff did not occur on the same days or even the same month in some cases. Terrace 7 is on a lower slope and the snew lay much deeper over the watershed then for the other terraces. The major part of the runoff from Terrace 7 was from melting snew, while for the other terraces probably less than half the runoff was from melting snew. For example, the runoff for the winter of November 1932 to March 1933 amounted to 6.42 inches for Perrace 7 and varied from .54 to 2.29 inches for the other terraces in this experiment, the major part of the runoff for terrace 7 being from relting snew. From November to December 1933 most of the runoff was from rain and Terrace 7 lost only .72 inches while Terrace 3A lost 4.23 inches. It should be noted that the above runoff figures are in inches and not in per cent runoff. Even though there was considerable runoff from relting snew for Terrace 7,

adil loss from Terrace 3A even though the slope was alightly steaper. The runoff was greater from Terrace 3A than for 17 which wise would point to the same conclusion. Detailed soil surveys are now being made and more complete oncy yields for 1934 should be helpful in interpreting the results for this exceptent.

The soil less from Terrace 7 was exceeded only by Terrace 34. From an examination of Tables 6 and 12 it will be noted that the rajor part of the runoff did not occur on the same days or even the mane month in some cases. Terrace 7 is on a lower slope and the snew lay or ch issuer over the varied than for the other terraces. The major part of the runoff from anterplace from the new lay or chief terraces probably less than half the runoff we from selting snew, while for the other terraces probably less than half the runoff we from selting snew, while for the other terraces probably less than half the runoff we from selting snew. For example, the runoff for ferrace 7 and varied from .54 to 2.35 inches for the other terraces in this examplement, the major part of the runoff for terrace 7 being from rain and formed 7 lost only .72 inches while Terrace 3A lost 4.33 inches. It should be noted that the above runoff figures are in inches and not in per cent runoff.

the per cent runoff probably was not large. The amount of snow on the watershed of this terrace was so much greater than for some of the other terraces that it would not be surprising if the mousture absorbed over the watershed of Terrace 7 was greater than the annual rainfall. Hans were made for measuring some of the variations in snow depth during the winter of 1933-34 but the snowfall was the smallest recorded for many years and no results were obtained. It is planned to continue these studies.

EROSION AND RUNOFF FROM TERRACES WITH DIFFERENT GRADUS (Sub-Project No. S.E. 7.4)

The terraces included in this experiment at its inception were

Terraces 16, 17, and 18, having grades of 18, 12, and 6 inches fell per

100 feet. After the first year fluxes and silt sampling installations were

made for Terrace 13 which is a level terrace, and Terrace 15 having a fall

of 24 inches per 100 feet. The letter two terraces are not quite comparable

to the others in all respects, such as land slope in the case of Terrace 12,

and length and vertical spacing in the case of Terrace 15. These factors,

however, are believed to be of lesser importance as compared to the grades

of the terraces.

The location of these terraces is shown on the map of Fig. 1, and the summarized results for 1932 and 1933 are given in Table 7. The detailed results for 1933 are given in Table 13. The soil loss was 1.28 tons per acre for the level terrace, 2.90 tons for a grade of 6 inches per 100 feet, 7.20 tons for a 12 inch grade, 10.36 tons for an 18 inch grade, and and 13.67 tons for a 24 inch grade. There was noticeable washing in the channel of Terrace 15 with a fall of 24 inches per 100 feet and some

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tailed results for 1988 are given of to abstract for a grade of 6

feet, 7.20 tone for a 12 inch grade, 10.36 tons for an 18 inch grade, and and 13.67 tons for a 24 inch gra c. There was noticeable making in the channel of Terrace 15 with a fell of 26 inches per 100 feet and some with a 12 inch fall did not show a tendency to cut although most of the soil washing into the terrace channel was carried to the outlet. There was noticeable decesiting of soil in the channel of Terrace 12 with a 6 inch grade, although the grade was sufficient to prevent the formation of bars across the channel. Soil was deposited in level Terrace 13 and bars formed across the channel causing ponding of water to some extent. Views of the terraces in this experiment are shown in Fig. . for the conditions at the end of the erosion season 1931-32 and again for 1933-34. The actual soil losses were greater for 1933-34 although the reverse would appear to be true from looking at the pictures. The erosion for 1931-32 tended toward small finger gullies which show in a picture while the 1933-34 was sheet erosion which in some cases was barely noticeable by observation although the measurements proved the losses were large.

The terraces with 6 and 12 inch grades gave best results from the standpoints of operation and soil losses. Level Terrace 13 lost less soil but bars formed in the channel causing ponding and killing the crop and emiangering the terrace embankment. Very little of the crop was killed in Terraces 18 and 17 with 6 and 12 inch grades respectively. The soil loss was more than twice as such for the 12 inch grade as compared to the 6 inch grade, although this difference was probably exaggerated due to slight difference in soil and land slope. It is believed, however, that the grades in general should be from 12 inches down rather than nore than 12 inches. In general the fall along the terrace should be more on the steeper slopes as there is more tendency for bars to block the channel, the terrace

veshing in Terrace le with a fall of 18 inches per 100 feet. Terrace 17 STATE OF THE STATE seil weshing into the terrace channel was corried to the outlet. There a stitus of sacras to four che che the charact of Cereate as with a 6 inch grade, although the grade was sufficient to present the formetion of ness one of more than all the largest and the arrange of deven site. and the state of the same to be the state of the same of the terraces in this experiment are shown in lig. J. for the conditions at the end of the erosion senson 1931-32 and again for 1534-34. The Line worth the bound is possible or common over some I from the factor RE-1891 rol morsors and escures. The erosion for 1931-32 set with such it must get to be within which there be not record the applications of the last street and the last transfer former and transfer former former and transfer former former former and transfer former former former former former former f depend only noted and being streamed and opposite sufferness. and the collection will be a second over 17 may 1. If the standard of play and that \$2 mornet bend assert the local property of the party of has been self a Children ber gallesse, referen Delmon 142 all begreit was not ag the terrace embashment. Very little of the crop was Filled in west line out agreements subspice of the order of the line of the comment was more than twice as ruch for the 12 inch smede os compared to the f Malle of any authorspoor offering the specialist airs annually of the SITURE BIJ DET GDETEN GENTEN IN DER MED GENTEN GENTEN GENTEN EIN DER AUS DER MENNEN GENTEN in ge and should be from 12 inches down rather than rore than 12 inches. Tolicore our real and a control of the control of t

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TABLE 7 EMCSION AND HON-OFF FROM CHADED TERRACUS.

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Vero	į	tone	•	9.29	9. 8. 8. 8. 8.	84 ° 54	10.30	Not yet Jerraco Fun-off at and t bined ar In workt
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日本が	Tot.	Inches Inches Petes Inches inches	0	7) e) Ř	. 93 0 0 0 3.452 4.362 7.363 3.34	4.363 2.25	15.28 25.55 26.7 26.7
Totul	Madin	indias	6.63	485	24 - 85 - 85 - 85 - 85 - 85 - 85 - 85 - 85		26.58	
42.		4-3	1931	1932	1032	1933 1933 1933 1933		10.5% 10.5% 10.18 10.18 10.18 10.18 10.18
	Period		Sept. to Dec.		Nov. to Dec. Total	Jan. to Mar. Apr. to Sept. Out. to Dec. Totel	Are. 1982-1933	Terrace No. 13 19 16 15





Ter. 15 24" fall/100' 1933-34

Fig. 6 Views of terrace channels at end of erosion seasons showing the difference in amount of erosion for grades of level 6, 12, 18, and 24 inches fall per 100 feet.



channel will usually have less cap city, and it is more difficult to obtain the desired grade in constructing the termice. Also if a side vertical special is used, the grade of the terrace should be steep enough so bare for sed by washing between terraces will not block the charmel.

(Sub-Project No. S.E. 7.5)

closed end level Terraces 9, 10, 11, and 12, having vertical spacings of 10, 15, 20, and 10 feet respectively are included in this experiment. The average land slope is about 23 per cent and the lengths of terraces 175 to 690 feet. During 1932 and spring of 1933, records were taken of the depth of water in the terrace channels. The capacities of terraces 9, 10, and 11 were exceeded several times and water flowed over the dyke at the end as shown in the innual Report for 1932. Terrace 12 hold all of the ranoff the winter of 1932-33.

The terraces were maintained the fall of 1933 and plans were made to continue the measurements of the depth of water. Newver, the runoff during becomber greatly exceeded the capacity of all these terraces and the dykes at the end were lowered so the excess water would easte and not overtop the terrace. Later steed in the channels of Terraces 2, 9, and 10, and 2A from December until after the simile of April, a period of four and or e-half months, even though the rainfall was below normal for Tebruary and practically no ranoff occurred during Eurch and April.

The results indicate that it is not practical to hold all of the runoff in a level terrace. The rates of rainfall and runoff are low, however,
as compared to other sections of the country and it is believed that tile
drainage of level terraces would take care of the excess water. It is hoped

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of 10, 15, 20, and 10 feet remeatively are cent and the lengths of a 175 to 690 feet. Lenth, 1720 and a cing of 1922, recenter ware the depth of artist in the terrace character of 1922, recentered formeds 5, 10, and 11 cars excerted reversal times and water flowed premared at the end water flowed premared at the end for 1922. Terrace premared the manufication of the manufication of 1950-30.

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results indicate that it is not practical to held all of the runa level terrece. The rates of an infall and runoff are low, however,
to other sections of the country and it is helieved that tile

that an experiment can be started soon to test out this possibility.

CONSTRUCTION AND BAINTENANCE OF TERRACES (Sub-Project No. S. E. 7.6)

A detailed account of the cost of terraces was given in the 1932

Annual Report and the types of terraces for different land slopes were

discussed and illustrated. Representative terraces on slopes of from 14.5

to 20.0 per cent had an average cost of \$22.98 per mile of terrace and

\$2.21 per acre. Under similar conditions the cost on slopes of from 20.6

to 27.8 per cent averaged \$34.07 per mile of terrace and \$4.63 per acre.

The cost per unit length of terrace was 50 per cent more for the steeper

land while the cost per acre was twice as much for the steeper land as compared to the more gentle slopes.

In operating tillage machinery on terraced slopes such as found on the Erosion Station it has not been possible to throw the soil toward the center from both sides. The soil is thrown toward the center of the terrace on the upper side and on the lower side the tandem disk is used to kill weeds and prepare a seed bed. The terrace is lowered a considerable amount during a summer fallow season. A record of the maintenance and heights of terraces is given in Table 8. In 1933 the heights of terraces were measured just after maintaining in the spring. The field was fallowed during the summer and the heights were measured again after the summer tillage operations of disking twice, harrowing and weeding with rod weeder. Terraces on land slopes of 20.0 per cent and less were lowered an average of 1.7 inches and terraces on land slopes more than 20.0 per cent were lowered an average of 2.9 inches.

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esst per cant averaged \$34.07 per mile of terrace and \$4.63 per acre.

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the Prosion Station it has not been cossible to throw the soil toward the center from both sides. The soil is throw toward the center of the terms on the upper side and on the lower side the tandem disk is used to kill weeds

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.ven in Table 8. In 1933 the designts of terraces were a saured post of an interved post of the sames and a sight were measured equin after the summer tillage open tions of

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... Perioni Q.S Reegarova as berewel ere tent per cent per content in the second an average of 2.9 inches.

TABLE NO. 8. RECOND OF THRACE CONSTRUCTION AND MAINTENANCE

Romants			Flanted to 1932	Flanted to sweaf
Waintein Terrnces April 5 1934	Inches 11.3 13.2 13.5 14.6	15, 21 18, 22, 21 18, 25, 36, 36	3 2 3 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	12.2 13.2 13.2 12.5 1.5 1.5
Mainthin Terrades Sept. 1933	1 1 1 2 2 3 4 4 4 5 6 7 6 7 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	PM 60 00 00 00	00 00 00 O 0	N N N O O
sept. 18	Inches	13.4	10.3 10.3 1.4	13.2
Height Terraces July 20-28 5 1993	11.5	11.5		meintain June)
May 23 1933	10.00 113.4 10.8 10.8	24258 24252	844 846 846 846 846	2 1 2 2 1 1 1 1 2 2 2 1 1 1 1 1 1 1 1 1
Maintein Perraces May 19, 1933	1. 5000000	→ Q Q G C	. a a u u u a	e M M M O O
Meintain Terraces Nov. 1932	11 12 14 16 16 16 16 16 16 16 16 16 16 16 16 16	மைவை	o in + 6 6 4	* * * * * * * *
Avarted Avarted Helight Oct.	100 has 9.8 9.7 6.1	्र प्रमुख इ.स. इ.स.	100 U U U U U U U U U U U U U U U U U U	13.6 15.5 10.0
Construction Pariod April Average and Height Sept. Oct.	41(M4 93 91 41(M4 932)	្តី ដូ ជ ជ ន ន រ	22222	38 38 38 48 88 88 88 88 88 88 88 88 88 88 88 88
Land	010	20.05 20.04 20.05	23.7 22.6 25.6 15.2	24.0 26.7 23.5 10.03 10.33
i è	12 m m		°2222	ងម្ដង់ខ្ល

The 8 foot Cornicans and Caterpillar Twenty tractor were used for constructing and maintaining terraces.

Measurements just after completion. નં જે જં

Upper Terrace. Land slope is sverage to center of ridge above.



The terraces were maintained in the fell by taking two trips on the upper side with the Corsicane, after thich the field was seeded to winter wheat. The heights were measured after the winter's erosion and averaged 3.1 inches higher than when measured the previous fell just before being maintained. The terraces are now compact and are not lowered as rapidly as during the first year. It appears that terraces should be maintained by making one or two trips along the upper side each season the land is tilled, which would be every two years using the summer fallow system, and annually if cropped sumually.

OF MACHINERY ON TERRACED LAND
(Sub-Project No. S.E. 7.7)

Lany of the implements used in the ralouse Region are especially Jesigned for use on steep land and operate quite satisfictorily. In some placer, however, ditches are becoming rather numerous and considerable difficulty is experienced. It has long been the practice to operate along the contour and work around the hills so far as possible and when a ditch becomes so deep it cannot be crossed, it interferes seriously with the working of the field. The smaller ditches, which are far more common, cause excessive breakage to machinery.

The various farm implements were discussed in the 1932 Annual Report and in more detail in the report of February 23, 1933. The implements in general operate successfully on the steep slopes but will not operate successfully across the terraces. The drilling of wheat with a nine-foot drill is shown in Fig. 7. Some of the disks over the channel do not touch

The heights were measured in the fall by making two trips on the upper side that the Corstoene, after which the field was ecoded to winter wheat. The heights were measured after the winter's ernsion and everaged 5.1 inches higher than when measured the previous fall just refere being maintained. The terraces are now corpact and are not forest as rapidly as during the first year. It spears that terraces should be insinticiped by without one or two trips slong the upper side each season the land is tilled, which would be every two years using the season fallow sparen, and samuelly if cropmed be every two years using the season fallow sparen, and samuelly if cropmed

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Suny of the implements used in the inlower negion are sepecially designed for use on steep land and operate quite satisfictorily. In some places, however, ditches are becoming rather num rous and considerable difficult, is experienced. It has long loon the practice to operate along the contour and rork around the hills so for as possible and then a ditch become as a leep it cannot be crossed, it interferes coriously with the working of the file field. The smaller ditches, which he for comon, cause

The verious farm implements were discussed in the 1982 mass Report and in more detail in the report of February 83, 1985. The implements in general operate successfully on the steep slopes hot will not operate successfully across the terraces. The drilling of wheat with a nine-foot drill is shown in Fig 7. Some of the disks over the channel do not touch





Fig. 7 (above) Drilling wheat on lower side of Terrace 16. (below) Drilling ridge and channel of Terrace 16. The nine foot drill is too wide to do a good job under such conditions. The furrow openers over the channel do not touch the ground.





Fig. 8 Hervy tandem disk operating on terrace



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the ground. This illustrates the difficulty using a wide rigid implement. This can be overcome by using narrower implements so that one wheel can be in the channel when the other is on the riage or where the slepe is not too steep the terrace can be built to take care of wider in lements. Best results are obtained on terraced land by operating perallel to the terraces and reducing the number of times a terruce is are sad to a rinimum. In order to do this successfully, an implement must be used which can operate buck and forth on a steep slose. The mold board ploy will not turn the furrow up the slope on the steer land and thus is not started to terraced land. A heavy tander disk, 22 inch disks with 9 inch specing, was used in place of the plow in working the terraced land, as shown in Fig. 8 . disk does not cover or lill weeds as well as a mold board ; low but by following with a second disking a good job can be done. For surver fallow work the everations can be made a few weeks apart and the net cost will not exceed that where the plow is used. The disk type of implement mixes the sturble with the soil rather then covering in a single layer about 6 inches deep and the erosion is noticeably less where the disk is used. Some feel that the crop yield will be much less where the disk is used. There was no apparent difference according to the measurements we have made as reported under Sub-Project to. 5.7. 7.13. Towever, additional records are needed before this can be determined conclusively.

SOIL MOVEMENT DOWN THE SLOPES ter so and many star (Sub-Project No. S.E. 7.8) To a com where

Frofile lines AA to HH, as shown on the map in Figure 1, were established to study therate of soil movement down the slope. Fermanent

thustrates the difficulty using a ride rigid in levent.

nel when the other is on the ridge or where the sleps is not too

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sing the number of times a terree is ore sed to a minimum. In order to do this successfully, as implement and forth can operate hack and forth on a steep slore. The mold board ploy will not turn the furrow up the slope on the steep land and thus is not alapted to terraced furrow up the slope on the steep land and thus is not alapted to terraced furrow up tandem disk, 22 inch disks with 2 inch specing, was used in

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dick does not cover or bill meeds as well as a bold torud plow but by

work the operations can be rade a few weeks upart and the net cost will not

sturble with the soil rather than covering in a simple layer about 6 inches deep and the erosion is noticeably less where the disk is used. Some feel

difference according to the mercanes make we have made as men and under Sub-Project No. S.M. 7.18. Nowever, whittional records are ed before this can be determined conclusively.

(Sub-Project No. S.R. 7.8)

rofile lines AA to HH, as shown on the map in Figure 1, wore es-

concrete bench parks were set at the upper and lower ends of each line and during the fall of 1932 levels were run over each line taking ground elevations every six inches along the slope. These measurements will be repeated the fall of 1934 and at later two year intervals. The two year interval is used because a two year rotation is being followed on most of the lines and it is desired to have the surface conditions the same each time the measurements are taken.

Lines AA,BB, and FF are on terraced land with different slopes and CC, DD, EE, GG, and HH are on unterraced land with different slopes. The cropping system is winter wheat and summer fallow (winter wheat 1932, 1934, etc.) for lines AA, BB, EL, FF, and GG. Line ED was we eat in 1932 and the following year was planted to grass. Line AE is in a rotation of wheat and fallow with trees planted on the ridge at the appear on the line.

The original measurements have been plotted and the tre year results will be taken the fall of 1934 and plotted for conversion with the original measurements.

RUNOFF AND SCIL LOSSES FROM LATTUREDS OF DIFF TENT
CHARACTERISTICS INCLUDING TENESCED LATE TENESCED LAND
comi to the feeture tenes (Sub-Project No. S.E. 7.9)

In this experiment the runoff and soil losses are measured for unterraced areas of different sizes and with different vegetative cover for comparison with each other and with terraced areas.

The runoff at Gaging Stations 2, 4, 5, and 6 is measured with Parshall fluxes and water stage recorders. It Coping Station 7 a x for stage recorder records the depth of flow in the stream shannel and the runoff is determined from a rating curve drawn from data obtained by correct meter reconserents.

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In this experiment the runoff and soil losses are measured for up-

. . "ds the copth of flow in the stream chancel and the reacff is determined

A Ramser silt sampler is installed at Geging Station 4 and for the other stations hand samples are taken frequently during periods of runoff. The hand sampling system is not entirely satisfactory and the results are no doubt subject to large errors on some days, although these are believed to be compensating over the erosion season. I runoff sampling device, described elsewhere in this report, has been developed for use on these larger installations.

The drainage area and d scription of the various wetsraheds is as follows:

Raging Station 4. This shall materaled of 2.33 screet is on a south slots averaging shout 14.5 per cent and is adjacent to a terroced erea as slown on the rap of Figure 1. The crossing conditions for the past three years were as follows:

1931- Poss during sun re-plented to winter wheat in fall

1932- Winter wheat--stubble standing after parvest

1933 - Stubble standing in spring -- fellowed during summer -- planted to winter wheat in fall.

Jacent to the Station and on similar slopes and soil conditions. The cropping system of wheat-fallow has been practiced on this field and this installation was established to measure the losses from a small watershed with this common cropping system. Gaging Station 6 has the same cropping system but on alternate years. The cropping system of Caging Station 5 the past three years was as follows:

1031- Winter wheet -- stubble left standing after hervest

1932- Stubble standing in spring-followed during summer-planted to winter wheat in fall.

1933- Winter wheat -- stubble left standing after hervest.

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Galley Station 6. This enterphen of 15.2 scrus is in a field selected to the station of 15.2 scrus is in a field selected to the station of 15.2 scrus is in a field selected to the station of the stati

1931- Stubble standing in spring--fallowed during summer--planted winter wheat in fall-1900 lead or self-actor pass 4.8 c

1032- Winter whent -- tabble left standing ofter bervest

1933- Stubble standing in spring--fallowed during summer--planted to winter wheat in fall.

Orging Station 2. This is a tylical watershed having a drainage area of 68.2 acres, the location being shown on the map of Figure 1. This watershed includes the plot setup and parts of 5 different fields so the surface cover is never uniform over the area. The principal crouping conditions the past three years were as follows:

1931- 57.8 acres fellow planted to winter wheat in fell--10.4 acres wheat with stubble standing after harvest.

the name of the latest the latest the latest terms and the latest terms are the latest terms

1932- 39 acres wheat with atubble left standing after harvest--19 acres peas--10.2 acres fallow planted to winter wheat in Fall.

1933- 43 acres wheat with stubble left standing after hervest--25.2

(26.1 equare piles). This area is representative of the wheat growing area of the valouse Region and includes a large enough area so that each year is a fair average so for as cropping conditions are concerned. The major parties is divided between winter wheat, peas, and summer fallow with some string wheat. A small part of the watershed consists of alfalfa, pasture, brush, timber, and roads.

The detailed records of runoff and soil losses for 1933 are given

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that he shall be the property of the second the state of the s Character of a first proper if extract pateur at tipes of the particle limits by 9 \$67. alle ni decem wednis ed Maniar Station 2. This is a typical materials having a frainge area and the second of the second o appropriate author more than the propriate and and and and and MANUFACTURE INTO the Law and t personal content of a proper solution of the particle output grows 2.72 PARRALL IN A. African and region parts of a . In ai tosia gadriv a botro : . . . Table law or the relients that also be defectable and pro-The state will be the selection of the second seros POT. If no bedreader aidt to erre e.P. . P soltate melena to come bound a call to a land to adminimum in a man whill family in a come of the of the print followers are the controlled a second to be suggested as the with a six of a few members and controlled the state of t which is to reside the same the same almost manufactured for in a medical state by a different advantage of the long face it is tenderal from Allerin Day Const. He World Delete has till and other allered of the Arguer Million are

in Table 14 and the summary of records since the installations were made are given in Table 9. The foot notes to Table 9 give the surface cover or crop occupying the fields for Gaging Stations 4, 5, and 6 while these conditions for Gaging Station 2 are given in the description of this station. In every case the soil loss is large during the season following the planting of winter wheat on fallow land or following peas and conversely the soil loss is small when the standing wheat stubble is in the field. The soil loss for Gaging Station 2 was 25.61 tons per acre during 1932 when most of the area was planted to winter wheat following fallow, and in 1933 the soil loss was 7.73 tons when an average of only 34 acres was in fallow. This wide variation was partly due to the different crop conditions and partly due to seasonal variation. Gaging Stations 4, 5, and 6 are each farmed as units so the crop is uniform over each watershed. In each case the soil loss was small while wheat stubble was standing, the loss being less than one ton per acre, and was large during the season following the planting of winter wheat.

For the year 1933 the soil loss for the watershed of 16,704 acres was 8.24 tons per acre and for the 2.33 acre watershed was 11.90 tons per acre with the two watersheds of 14.4 and 15.2 acres being between. The 68.2 acre watershed lost 7.73 tons per acre, the smaller loss probably being due to a vegetative cover of a greater per cent of the area. In 1932 the soil losses for the 2.33 acre and 68.2 acre watersheds were 22.53 and 25.61 tons per acre respectively. It is planned to continue these measurements in order to determine the losses over large watersheds as compared to small watersheds and plots.

the one contributed by an administration of the land of the NAME OF THE OWNER OF THE PROPERTY OF THE PARTY OF THE PAR early there is been an an entired portrol will all aim wit tally prove the and the second of the second o THE RESERVE OF THE RE with the most revenified we look builts to April weglete to extract our many about 1765-1, tasks tables of the part of the Language filler of believes necessive and the second of the contract of the contract of the second o and the period for the property parents are not by the series of the below at price to an year an and been 10. " and seed they say that The second of th DEF ADMINISTRATION AND REPORTED BY SHEET AND ADDRESS OF THE PARTY ADDRESS OF THE PART loss being less than one fon per sere, and was large during the season . trade retaine to gailing of gaivellof

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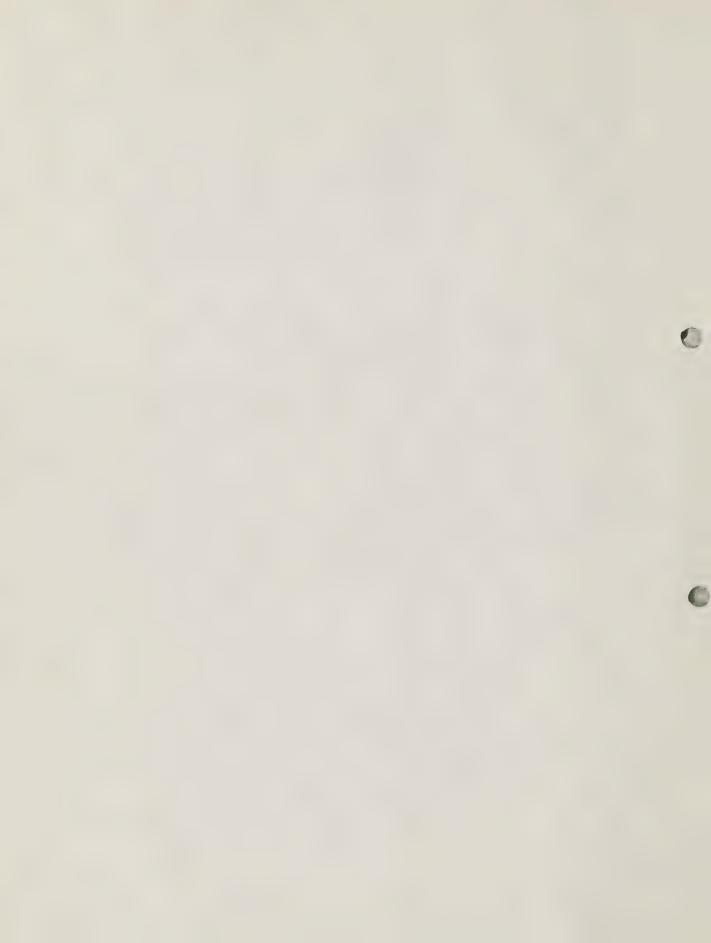
For the year 1933 the soil loss for the watershed of 16,704 acres acres with the two watersheds of 14.4 and 15.2 acres being between. The due to a vegetative cover of a greater per cert of the area. In 1932 the soil losses for the 2.33 acre and 68.2 acre watersheds were 22.53 and 25.61 in the case and plots.

TABLE NO. 9, EROSION AND RUN-OFF FROM MATERIERS
OF DIFFERENT SIZES AND, GHARACIERISTICS

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		theling	Anchor	Inches	Inches Brehes trokss	Trenes	inches	Puon	tens	1000	a section	ton
an. To Apr.	1932	36.11	T85"-	i i i	1 Stallod 8.52	9.52	not-	22,502	\$ 3 ·		25,07	
May to Cet.	1932	5.56 6.86	1.66	1/3		. 13 0	inctall ed .18	6:0.	1	63	a L	0
lo al	2661	24.38	6.04			9.71	· · · · · · · · · · · · · · · · · · ·	22,53			75.61	
Arr. So Unit	1033	9.25	5.303	1.697	6.603	6.110	96"	203	1500 6 862	£07°	9	3.25
pr. to Oot.	1933	9.36	5,	a,	B S	4	4 l	à,	0 (0	a i	S,
Nov. to Dec. Total	10.33	28.77	10.73	5.80	12.03	10.54	13.06	11.30	1 - 1	8,32	1.73	H-24
Mrg. 1931-1938		26.58	38 8			10.12		96 91			18.67	

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En Are	2,33 scren	Section B	B CTOB	8,427.05
Dre in	2 - 35	15.2	611.2	<u>z</u>
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G. a. No.				
/i	4	n e	F1	E=

Whiter whent on callow
 Standing wheat stubble



The soil loss from graded terraces varied rather widely, depending on the land slope, soil and special conditions as discussed under the terrace experiments. The two year average soil loss was .57 tons per acre for Terrace 7, 1.82 tons for Terrace 5, and 7.20 tons for Terrace 17.

The average annual soil loss of these three terraces is 3.20 tens per acre as compared to an average of 16.67 tons and 16.90 tons per acre for Gaging Stations 2 and 4 respectively.

The water losses follow to some extent the soil losses, although THE CHIPCOLD PRODUCT OF THE there are frequent exceptions. When the runoff was the result of rain falling on unfrozen ground, the soil loss was greatest from the areas having the most runoff, as for example: November and December 1933 as shown in Table 9. However, when the ground is frozen and there is considerable snow, the snow is likely to be deeper on fields with standing stubble as the teniency is for the snow to blow off portions of fields having no vegetative cover. with the ground frozen the soil will not a b-STREET, STREET sorb the water and a large amount of runoff may result, as for example, THE PART OF STREET, 47 LB from January to March 1933 as given in Table 9. Gaging Stations 4 and 6 with a cover of wheat stubble had 5.30 and 6.60 inches runoff respectively with soil losses of .29 and .40 tons per acre, while Gaging Station 5 with 4.69 inches runoff had a soil loss of 9.05 tons per acre. The upper few inches would sometimes thaw in places resulting in serious erosion for CHARLES THE PARK AND DESCRIPTION OF THE PARTY OF Gaging Station 5, while the stubble on Gaging Stations 4 and 6 held the soil so the erosion was negligible. For the larger drainage areas, there healt, and of particle whall all and the same of is a considerable amount of seepage included in the records of the water the training policy accounts to your The soil loss from graded terraces varied rither widely, depending on the land slope, soil and special conditions as discursed under the terrace experiments. The two year average soil loss was .57 tons per acre for Terrace 7, 1.82 tons for Terrace 5, and 7.20 tons for Terrace 17. The average annual soil loss of these three terraces is 3.20 tons per acre as compared to an average of 16.57 tons and 16.90 tens per a cre for daging stations 2 and 4 respectively.

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losses. This is true especially of Gaging Stations 2, 6, and 7. It is difficult to separate this from the surface runoff. This seepage increases the amount of the water losses by a considerable amount but has practically no effect on the soil losses.

CHECK DAMS IN GULLIES AND TERRACE OUTLET DITCH'S (Sub-Project No. S.E. 7.10)

In the fall of 1933 check dams, or baffles, were installed in the two terrace outlet ditches on the station under a lublic works froject. Prior to the installation of these check dams, there was considerable cutting in some places, especially the longer ditch draining terraces 1 to 7. The baffles were made from 2 x 12 rough plank spiked together with a 4 x 4 post at each end. A drawing of the baffle is shown in Fig. 9. These baffles were installed with a drop of 2 to 2.2 feet between baffles, the slight variation being made to fit them in between terraces. The horizontal spacing v ried from about 8 to 20 feet depending on the land slope. The crest of the baffle was set slightly below the desired level for soil in the ditch and the ditch graded to a smooth, almost flat bottom with sloping banks and with 3 to 6 inches of soil covering the baffles so that it can be readily crossed with fare rachinery. The ditch was planted to brome grass with a small mixture of ladak alfalfa. Views of the ditches after the grass was seeded are shown in Fig. 10. This ditch will be a good location for testing the effectiveness of a sod forming grass in gully, control, and at points where any washing may start the baffles will prevent the extension of the wash.

In the heavier soil the clay subsoil offers great resistance to rapid erosion and gullies are only a minor problem. Some of the most productive

losses. This is true especially of Geging Stations 2, 6, and 7. It is

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the amount of the water lesses by a considerable amount but has practically no effect on the soil lesses.

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In the fall of 1933 check come, or beffles, were installed in the anoterroe outlet citches on the station under a inhice order irreject.

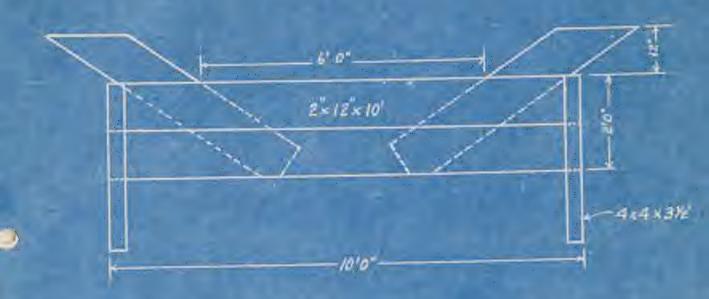
Inter to the installation of these sheek dams, there we seemsiderable cuiting in some places, especially the longer ditch dreiming terraces 1 to 7. The beffles were made from 2 x 12 rough plank spiked together with a 4 x 4 post at each end. A frawing of the buffle is shown in Fig. 9.

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In the heavier soil the clay subsoil offers great resistance to rapid erosion and gullies are only a minor problem. Some of the rost productive



Material
3 pieces 2x12x10' (cut one andiagonal for wings)
2 +x4x3½
1 lb. 20d nails
Total 69½ bd.ft. lumber

Fig. ? Baffleused in Terrace Outlet Ditches







(b)
Fig. 10 (a) View of outlet ditch for Terraces 1 to 7, and (b) outlet ditch 15 to 18, after construction of baffles and seeding to grass.



land, however, is in the Walla Walla region and the foothills of the Blue Mountains, and here the soil is lighter and gollies form easily. In Figs. 3 and 4 are shown views of gullies. In field trips over the area we found where gullies divided fields in two or more parts making small irregular shaped fields as compared to the large easily worked fields of a few years ego. Studies are being made of methods of filling in these gullies. In the case of the larger gullies, it appears that dams of various kinds and brush or straw should be used to help hold the soil. The banks should be plowed in and the gully seeded to grass as soon as possible. If the season is not favorable for grass, wheat should be planted as it will grow under adverse conditions and greatly helps in holding the soil.

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Crop yields of winter wheat were taken of a deep tillage plot in field 4 which was described in the 1932 report. The ground was worked to a depth of 16 inches when the ground was dry and hard, following a crop of wheat in 1931. The field was all plowed the spring of 1932, fallowed, planted to winter whent, and harvested the summer of 1933.

There was no erosion the winter of 1931 and only a small amount in 1932 and no difference was apparent between the deep tillage plot and adjacent check plots. Crop yields were taken of sample plots along the east and west edges of the deep tillage plot and for adjoining check plots, the yields being as follows: The points 16 another apparent of the plots are plots.

Since Mountains, and here the soil is lighter and gellies form ensity.

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(Sub-. reject No. S.D. 7.13)

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Yield of Winter Wheat in Bushels Fer Acre

lest sile of	lot		Last side of		-
Deep tillage		Dee	p tillage	check	
19.5	50.3		15.4	32.1	
28.1 17. 50 00	38.1 on pie	of a where	20.6 ETT 5.30	d 07 65 16.4	
31.0	46.8		26.9	44.66	
32.1	46.7		.58 • V	. 56.0	
59.9	43.9		52.0	53.2	
50.8	43 .4 777 00	Section 11 Section 12	58.2	54.6	
54.2	53.7 1 5 50	Frozent No	, 53.2 7.1	54.9	
51.7	42.2		55.7	48.1	
59.7" s but he	2 g 59.4 gaith	C4568 (50)	56.4 on mi	2,35 to 53.8: At 1/4	
62.1	58.8		50.6	47.3	
49.2	52.9	IR. The	43.6	46.3	
50.5	59.7	Avg.	44.7	46.1	
53.1	52.1			3F akon	+inc
47.8	47.2	1. Sample	e plots taken	every 15 yards star	erna
24 45.8 value to	c. 41.6 41 016	o? at lo	ver edge of p.	lot.	
32.0	26.1				
ent of		以 意外日 初班产品	met .		
Avg. 45.5	45.7				
VAR. 40.0	2041			IN TAXABLE PARTY.	

The difference in yield is too small to be significant and the deep tillage seemed to have no effect on the yield. Except for the upper slope where the soil is thin in places and the lower slope where the drainage is poor, this is an excellent piace of land. The average slope is about 14 per cent which is more gently sloping than most of the land. The average yield of winter wheat for "ield 6 was 41.7 bushels per acre (weight of wheat delivered to elevator).

On the central plots a 1/100 acre plot which was excavated and filled in with subsoil had much less erosion and an increased yield as compared to undisturbed subsoil. Following this 2 plots were selected where the subsoil was exposed in field 2 and the plots worked with the Killefer to a depth of 16 inches with the points 10 inches a part. The work was done in the spring when the ground was moist and the land was fallowed and planted

Tield of Winter Whent in Bushels Isr Acre

		February Co.	4.11 /12
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2862	4.31	1.	1
16.4	3.08		7
1.1	A . A . A	1988	
	₹.88	1 .	ľ a
0.88	0.38	10,00	
2. 86		The Colonia	1.
3. Ad	\$.80	70.60	
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•	1.	,	
8.74	3.03	a	1.
Se 1 2	7 2 4	`.	e .
	. 71	F. F.	e i
·	,	ERRE	53.1
		2000	4 7 4
	Hedra cont or home		45.8
4.5	et lower edge of 11	9.19	
• • • • • • • • • • • • • • • • • • • •		26.1	32.0
		٧	
		. 1	4 1 4 1

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to winter wheat in the fall. The location was not favorable either for measuring runoff or for making observational comparisons of erosion. The crop yield will be measured in 1934 and if results are favorable, the tests will be continued on plots where the runoff and erosion can be measured.

TESTING OF HOLE DIGGING MACHINE (Sub-Project No. S.E. 7.12)

The hole-digging cultivator was tested on various slopes at the Soil Erosion Station as given in the 1932 Annual Report. Due to the steepness of the slopes and the freezing and thewing, the holes were soon filled and according to observations of the areas, there was but slight difference in the amount of erosion where the hole-digging cultivator was used as compared to adjacent check areas. The crop yield was less where the cultivator was used.

On a cooperative project at the *dams Branch Substation at Lind, the cultivator conserved 1.0 inch more moisture and the yield of wheat was increased .9 bushels as compared to the check areas. I lans were made to continue this experiment the fall of 1933 but the station was practically discontinued and the experiment was not carried out. It is planned to make additional trials in the dryer, more gently rolling wheat section.

(Sub-Project No. 3.E. 7.13)

The purpose of this experiment is (1) to determine the hert method of turning under stubble, legumes, or other plant residues, and to develop special mechinery, if necessary, for use in doing this work; (1) to study the effect of the different plant r sidues on erosion, soil tilth, fertility, moisture conservation, and crop yield; and (3) to determine the

(Sub-Project No. 5.E. 7.12)

The hole-digging cultivator was tested on verious singles at the soil Brosion Station as given in the 1980 Annual Report. Due to the skeepmens of the slopes and the freezing and thewing, the holes were soon filled and according to observations of the armae, there are but elight difference in the amount of erosion where the hole-digging cultivator was used as compared to adjacent check areas. The crop yield was less where the cole

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GORDAN HONGTT TO REALESTING

The purpose of this experiment is (1) to determine the best method turning under stubble, legunes, or other thant residues, and to devolop aschinery, if necessary, for use in defect this work; (2) to study the effect of the different plent r sidues on erosion, soil tilth,

best time of turning under the plant residues.

A series of plots were started the spring of 1932 to study the effect of different as set is llow sethels on erosion and cref yield. One area as plowed with a rold board plow and weeded with a rod weeder, and another area was dish d with a regular & foot tundem disk and weeded with the same in lement. Both areas were divided and the stubble burned on half. Where the ground was slowed, the stubble was practically all in one layer about six inches below the surface and the where the disk was used the stubble was mixed with the strace soil to a depth of report five inches. The runoff and soil lesses were not measured but from observation it apperred that the crusion was much less where the disk was used and the stubble not burned. There was no apparent difference in the arount of erosion for the other three plots, disked with stubble berned, glo ed with stubble turned under, and plowed with stubble burned. The plots extended over a ridge including south slope, hilltor, and north slope. Yields of sample areas were taken for each condition, the results being a follows: Tillage ! lots: Yields of winter wheat in Bushels per .. cre

	Sout	h slove	Hill	top	North slope		
2 p. 1 4 301 2	plowed	disked	plowed	disked	plowed	disked	
stubble burned	28.1	25.0	23.8	28.9	45.0	60.2	
19 99	34.3	35.9	26.1	16.8	43.9	63.4	
Average	31.2	30.5	24.9	22.9	44.5	61.8	
Stubble unburned	26.8	30.3	31.4	26.3	48.2	56.6	
Average	25.9	34.2	32.6	29.4	49.8	50.3	

The yields on the plots varied from 16.8 bushels per acre for one sample plot on the hilltop to 63.4 bushels per acre on the north slope.

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off whole of 989f to pring off betrate erev stoll lo seines A end . Sfelt gorn bue moisors no shodsen wollal newers thereil ib lo soelle rea w a plowed with a rold board rlow and weeded with a rod weeder, and another area was dished with a reguler 8 foot tundem disk and weeded with the same im lement. Both snees were divided and the stubble burned on half. Where the ground was plowed, the stubble was practically all in one layer about six inches below the surface and them where the disk year seed the stubble was mixed with the serface soil to a depth of about five imphes. The remoff and soil lesses mere not messured but from obes Toner enT eidduis end how here was wish end erec'w age! down enw noison edd tel berseq There was no apparent difference in the arount of erosion for the other three plots, disked with stubble bruned, closed with stubble turned under, and plowed with stubble burned. The plots extended over a ridge including south slope, hillton, and north slo e. Yields of supple areas were tuken for each condition, the results being a follows: Tillage llots: Yields of winter wheat in Bushels per Acre

pagniq SALD stubble burned 28.1 8.83 25.0 , 0.88 v Lale 9 41.75 . 6 Stubble unburned 26.8 - 4 . 31. 30.3 1.1 " 1. " 1.00 5

The yields on the plots varied from 16.8 bushels per sere for one

There is no apparent trend in yield either in comparing plowing against disking or turning the stubble under as compared to make the stable was burned. The variation between the two sample plots for each condition was frequently nore than the difference between the averages. It is believed, however, that the results for this year show that the yield was practically the same for disked fallow as for plowed fallow and that the turning under of the stubble did not reduce the yield. The stubble was heavier on the slope below the plots and the turning under of this extremely heavy stubble might have a detrimental effect on the yield. The common practice is to allow the straw to run out of the combine in a windraw, and it is almost impossible to operate a plow through such a windrow in heavy stubble. A straw spreader on the combine would no doubt make the turning under of the stubble much easier.

turn the furrow up the slope on the steep land, the roldboard plow could not be used to advantage. Therefore, a disk type of implement was used in place of the plow. The disk was of the tandem type with 22 inch disks spaced 9 inches apart. The disks in the front gang were 11 turned one way and the rear gang the opposite way. This implement would operate back and forth between terraces or on the terrace and do about the same work in either direction. The stubble was worked into the soil to some extent but some was left on top and not all the weeds and volunteer wheat were killed. The next tillage operation was made about four weeks later at about the time plowed fallow would be harrowed or weeded the first time.

There is no appears trend in yield sidner in comparing plowing Agrinst disking or turning the stubble under as congared to where the stubble was burned. The variation between the t.o sample plots for each condition was

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The terraced land was fallowed in 1950 and so it is immersible to turn the formow up the slope on the steep land, the holdboard plow could not be used to advantage. Therefore, a disk type of implement was used in place of the plot. The disk was of the landemary with 22 inch disks apaced 9 inches apact. The disks in the front gang were all surged one way and the rear gang the opposite way. This implement would operate back and forth between terraces or on the terrace and do neout the same work in

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The regular 8 foot tander lisk was used, 18 inch lisks with a inch spacing. The partects harrowed not red were used for later this go operations the same as for pleved fallow. heat we plented in the fall and from all indications the yield will be equivalent to follow which was plotwed. The cost using the disk for the first two operations is believed to be about the same as for plowed fallow but the disk mixes the stubble with the soil and the erosion is noticeably less.

Strip-Seeding: The tillage operations are being studied in connection with strip seeding for summer fallow fields. Strip seeding in a summer fallow field is shown in Fig. 11. The gaps between the ends of the strips are to provide check areas for comparison to the strip seeding. In field practice each strip would be continuous. The strips should follow the contour in a general way although they may vary somewhat for convenience in working the field. In order to keep the cost at a minimum the spacing setween strips should be analors so summer tillage of rations can be conducted without crossing strips.

The strips as shown consist of nine-foot drill widths of winter wheat which were seeded in the spring of the sum or fallow seeson. The wheat makes considerable growth during the summer but the winter variety does not mature and will usually live over winter. The strips can be harvested the following summer with the remainder of the field which is planted in the fall to the same variety of winter wheat as was used in the strips. The effectiveness of this practice in erosion control has not yet been determined.

The regular 2 feet tenden lisk was used, 18 inch disks with 6 inch apseing. The peg-tocth harrow end red resder were used for later tillage operations the same as for piewed fallow. The same as for piewed fallow. The disk indications the yield will be equivalent to fallow which was plotwed. The cost using the disk for the first two operations is believed to be about the same as for plowed fallow but the disk mixes the stubble with the soil and the areaion is acticeably less.

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Fig. 11 Strip-secding on steep slope on Soil Erosion Station.

Single drill widths (9-foot) were seeded to winter wheat in the spring of the summer fallow season. The wheat makes considerable growth during the summer but the winter variety does not mature and will usually live over winter. The strips can be harvested the following summer with the remainder of the field which is clauted in the 'all to the same variety of winter theat as was used in the strips.



WIND EROSION STUDIES

Wind erosion is a serious problem over several million acres in the drier sections of Washington, Oregon, and Idaho. The land might be classified in three general classes as: (1) Grazing land which has never been plowed, (2) Land once farmed but now abandored due to wind erosion, (3) Land now under cultivation but subject to serious wind erosion.

The land under (2) and (3) had a good stand of native grasses before being plowed but these grasses come back vary slowly when the land
is abandoned.

Letitude 46° 49°N. and Longitude 112° 49° N. has been furnished without cost for use in conducting studies on wind erosion. The adjoining 32°C acres can also be obtained if needed. A survey and contour map of the 48°C acres was made in 1933. The 16°C acres tract and a portion of the adjoining tract is shown in Fig. 12. This tract of land was first formed about 4°C to 45 years ago. A house was built, and orchard any shade traces planted. The town of Cunningham which adjoins the property has two or three hatels, herdware stores, livery stables and the usual business establishments.

If the present time considerable areas of land are abandoned, the 16°C acres being abandoned from 10 to 15 years ago. The town of Cunningham new has but one business establishment, a combination store, filling station and post office. Nost of the houses have been torn down.

In the fall of 1993, twelve plots were planted to crasses at the locations shown on the rat of Fig. 12. The grasses used care crested wheat grass, slender wheat grass, and quincy grass. Different tillage methods were used in planting the grass as follows:

Wind erosion is a sorious problem over several million acres in the drier sections of Washington, Oregon, and Idaho. The land wight be classified in three gameral classes as: (1) Grazing land which has never been plowed, (2) Land once farmed but now shendored due to wind arosion,

The land under (2) and (3) had a good stand of native presses bear fore being plowed but these grasses come back very slowly when the land is abandoned.

A 160 acre tract of land located near Gunningham, Vachinghow, in Latitude 46° 49'N. and Longitude 118° 49'N. has been furnished without cost for use in conducting studies on wind erosion. The adioining 32° acres can also be obtained if needed. A survey and contour man of the 48°C.

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to 45 years ago. A house were built, and erchard and shade trees planted.

herdware stores, livery stables and the usual business establishments. At the present time considerable sness of land sne standoned, the 18C acres being abandoned from 10 to 15 years ago. The town of Cunningham now has but one business establishment, a combination store, filling station and post office. Lost of the houses have been torm done.

In the fall of 1933, twelve plots were planted to transes at the locations shown on the map of Fig. 12. The gresses used were crested wheat were used in planting the grass as fellows:

Broadcast seed with no tillage Flant with single disk drill with no other tillage Disk land and plant with single disk drill Burn off vegetation before disking and planting.

taining a stand of research and any nathod which is practical and he levels cost. The season following the planting of he cannot must favorable but so a sults will be explicitly and it is determined whether the plants survive the summer of 1934.

tillage practices which have continued under a literation errors writer tillage practices which are new following in social to a small be combusted of a time when the a letter on the fittle soil is such that whose fill be formely less the shallow and time from it should be left on the surface rather than turned under.

ith no tillego e disk drill with no other billere nd and plant with single disk drill I versistion before disking and planting.

is land is not wellenble enough to justify much expense in ob-

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of the second of the bodtem was bas sort to break

On error which have continued under collivation where are certain tillers areactic a which are very belocal in a constitution of errorious. The tillers should be conducted at a time when the acidature content of the soil is such that clode will be formed; also the stable or regal tive growth about he left on the surface reflect than to and under.

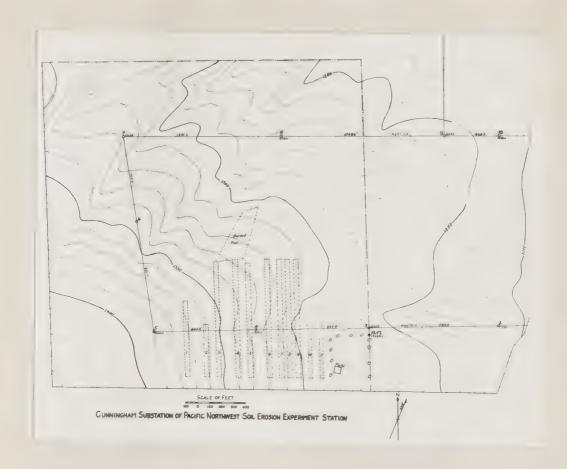
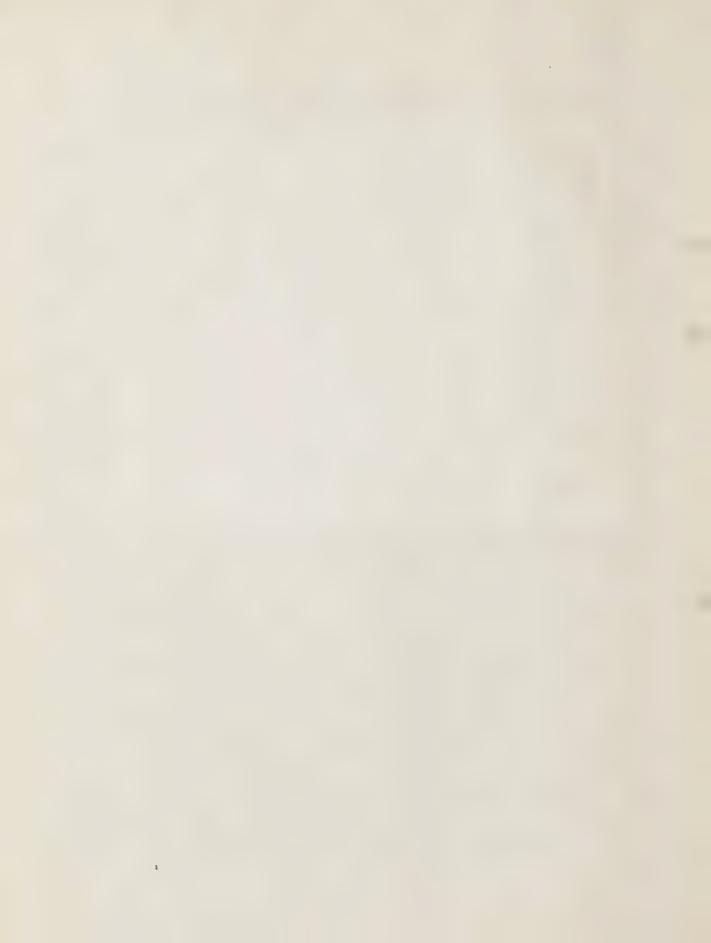


Fig. 12 Map of tract at Cunningham, Washington, used for studies of Wind erosion.



DIVISOR USED ON 1/10 ACRE FLOTS AT THE FACTFIC NORTHWEST SOIL ERGSION STATICE, FULLWAY, WASHINGTON

In designing a divisor for use on 1/10 acre plots, it was desired to obtain the same proportion of the flow for all heads, the desired all most being approximately 1/20 of the total flow. The season of erosist is during the winter and as the installation would be subject to snow and to freezing and thawing, it must be easily accessible for cleaning out snow and for checking the level of the flume from time to time. The original installations were to be handled out of rublic Norks funds and for this reason must be simile enough to be installed with the labor available and low enough in cost so the installations could be completed with the funds available. The divisor, as planned, can be quickly and easily cleaned and as the aliquot is removed in one stage the adjustment can be quickly checked and corrected if necessary.

The installation consists of (1) a screening convertment, which may also act as a settling chamber for part of the soil, (2) a flume which will spread the water uniformly at the outlet, (3) the divisor for taking off the aliquot, the divisor consisting of a slot open - .4 inches mise leading into a pipe to (4) the sample tank. Figures 13 and 14 show the different views of the installation.

(1) Screening Compartment: This compartment as shown in the thotograph of Figure 13 is 30 x 96 inches by 12 inches deep at ends and 16 inches deep along sides of screen. The bottom has a fall of 1/4 inch per foot draining toward the fluxe and is flush with the fluxe. Considerable soil settled in the box, however, and as some soil will have to be handled

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This compactment as shown in the choice of ligare 13 is 30 x 96 inches by 12 inches deep at ends and 16 per a slong sides of serven. The bottom has a fall of 1/4 inch per





Fig. 13 (above) General view of installation for collecting 1/00 aliquot from field plots. Runoff enters at left running on to screen and from this convertment runs through flure where 1/10 aliquot is taken off at lower end of flure. The flume is protected from wind by a box (or en top and bottom) around the siles and lover end.

(below) Same view with screen and hex recoved.







Fig. 14 Views of flume and divisor. (above) Looking at flume from outlet end. Note position of devise for taking of 1/20 sliquot. (below) Looking toward outlet of flume. Later enters flume at end of tox which appears as a source light area in licture and on leaving flume 1/20 aliquot is token off by an open slot onto which the water drops. 1/20 is conducted to sample tank and rest is wasted.



anyway it is believed a floor 3 to 6 inches below the floor of the flume might be better. The screen is the most important part and should be designed to remove all grass, roots, etc. The mesh should not be larger than 8 openings par inch. A 6 mesh screen 30 x 60 inches we used and there was no tendency to clog the screen. It is believed a second screen, either the same mesh or smaller, would recove that for roots get through the first and provide mided protection against any errors caused by trush. This man compartment right be varied to spit conditions the only essentials being that it remove all trush and provide a entire to the flux.

- (2) Fluxe: The fluxe is 24 inches long, 5 inches wheat entrance, 8 inches wide at discharge, and 7 inches deep. It is similar to the fluxes used in the tland Divisor. Views of fluxe are shown in Fig. 14. The horatory facilities were not adequate to test the fluxe at the higher flow but the capacity is in excess of .3 cubic feet per second. The fluxe has a grade of 3/8 inches per fact or a drop of 3/4 inch from the wayer to the lower end.
- midway between the center and the edg.. The divisor was attached at the 1/4 point rather than the center, as it was lelieved a more representative sample would be obtained in case there was a variation in the soil context between the center and edge of the flume cutlet. The water falls on to the edger of the plates forming the slot and the section of rater falling beautien the parallel plates of the divisor is .4 inches and the plates are flared out

endited to remove all grass, roots, etc. The mesh should not be larger there was no tendercy to clog the screen. It is bolicred a second screen,

the first and provide added protection against any enjoys occash by trash. This upper compartment might be varied to suft conditions the only concuritals being that it remove all trash and provide an entrance in the flower.

- (2) Figure: The flume is 24 inches long, 5 inches with at the flumes sinches wide at discharge, and 7 inches deep. It is similar to the flume are shown in Fig. 14. The used in the pland Divisor. Views of flume are shown in Fig. 14. The laboratory facilities were not adequate to test the flume at the higher flow but the capacity is in excess of .3 cubic feet per second. The flume has a grade of 3/8 inches per foot or a drop of 3/4 inch the upper to the lower and.
- (5) Sivisor: The divisor is attached to the le or and of the flume midway between the center and the edge. The divisor was attached at the last last last point rather than the center, as it was believed a more reprosentative sample would be obtained in case there was a veriation in the soil contact between the center and edge of the flume outlet. The water falls on to the edges of the plates forming the slot and the section of ester falling beattween the plates is collected in the sample tank. The opening between the parallel plates of the divisor is of inches and the plates are flared out

to provide clearance for the water after it has passed the edge. The plates were made of 18 gage pelverised stell and the missed were sharpened by filing on the outside. Fig. 14 shows how the plates are flared out to form an entrance into a 2½ inch relvanized his connected to sample ank. The edges of the plates are ‡ inch below the floor of the flume at the point of connection and make a 45 degree angle with an extension of the line of the floor of the flume. A box, open to and better, surrounds the flume and divisor as shown in Fig. 13 and is used to prevent wind blowing the water to one side of the flume.

(4) Sample tank: Any watertight tank of the required capacity is satisfactory. Galvanized steel tanks with 1/4 mitch cone shaped lids were used on the installations.

Calibration: The flume was tested first with a small flow of water at the procion station and later at the hydraulic tabor tary at the State College of ashington. The results of the calibration were as follows:

6	AT.	TRR	A OP	TO	137	OF	83	THE	91	£*3.	0	173
60	2234	TIN	57 de 9	70	173	UF	2,3	J. V	2.1	13	63	sч

(1) Flow in en. ft./sec.	(2) time sec.	(3) Waste	(4) Aliquot	(5) Total	(6) Ratio (5)*(4)	(7)
.00301	217	37.50	2.25	39.75	17.7	Variation 1 to 20
•00552 •0074	130 300	42.375	2.375 6.94	44.75	18.9	5.5
.00838	360	179.0	9.19	139.34	20.2	- 1.0 - 2.5
.0156	197	182.0	10.00	192.0	19.2	+ 4.0
•0505	71	222.5	11.44	233.94	20.4 20.0	- 2.0
.0907	40	215.5	10.81	226.31	20.9	0.0
•123	29	212.5	10.69	223.19	20.9	- 4.5

The calibration was not entirely satisfactory as the Firme was not

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ned by filling on the outpids. Fig. 14 shows how the clates are flared out to form an entrance into a 25 inch calvenized pipe commetted to seemals to the flame of the point of connection and mike a 45 dames angle with an extension of the lime of the flame. A hox, open top and extension of the lime of the flame. A hox, open top and

(4) Sample tank: Any watertight tank of the required canneity is satisfactory. Galvanized steel tanks with 1/4 pitch cone shaped lids on the installations.

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To of I national	(5) 4 (3)	- 865	BIL	, artt	• 0 / B	
7,11	>	7,11	- ` ` ` ` ` ` ` ` ` ` ` ` ` ` ` ` ` ` `	75.33	211	5 · · ·
_ a 	2.12	et.89f	0.19	170.0	01	
7.4.0	20.2	108.0 233.94	10.00	182.0	110	1450.
0.5 -	U+U-		77.5	215.5	40	#020, 7090.
3.4 -	6.08 6.08	223.19	10.69	2.313.5	28	cor.

ton man sout on the continuity satisfactory as the flume was not

at the entrance to the flume. The maximum head obtained in the calibration was less than half the capacity of the flume. The largest error was at the lowest head with a flow about 1.3 gallons per minute which is an extremely low rate of runoff for a 1/10 acre plot. The errors in calibration are believed to have caused the per cent variation to be irregular. If the proportion, for example, became smaller for the bight less that could be everyone by widening the clot toward the apper end.

There was no difficulty are to freezing and thowing as the divisor and flume were 6 to 12 inches off the ground. The flume was festened to cross pieces and posts as shown in Fig. 14. The lower and or the acreen compartment was also off the ground at most of the losts lettons. A slight movement of the screening compartment would probably not affect the results as long as the lower end of the flune was held level.

The flume size selected is believed to be adequate for remaif of a 1/10 acre plot at sulhum, sustington. It is quite possible it might not be large amough in regions of ore income related. The same general idea could be used with larger or smaller flumes and life smaller cliquot was desired, two stages could be used which, if the first a general/20 and the second 1/10, the allignor could be 1/20 x 1/10 or 1/200. A suitable screezing compart and is essential to the success of this a thou and for this reason, it is limited to comparatively small areas, greatly less than one acressors began and Could be 1/20 x 1/10 or 1/200.

On the larger watersheds, of five to fifteen acres or more, an excessively large silt hox is necessary, which is expensive both in original

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half the capacity of the flure. The largest error was at the head with a flow about 1.3 gallons per minute which is an expect of runoff for a 1/10 acre plot. The errors in calibration d to have caused the ner coat variation to be irregular. If the process for exumple, became smaller for the bigher heads this could be rescore by midening the shot toward the upper cas.

Toelvin edd en unigned bas maisharl of ean yll willib on ang s

cross picces and posts as shown in Fig. /4. The lower and of the nersen movement of the sersening conject and not described the results story as the lower end of the flore was held level.

The flure size selected is he ever to be ede on

42 %6 Add Times francess con on ver-

larger vatershads, of five to fifteen acres or more, an

bette 1777 vince flow

Deposits Lide 1977 Allerin Table

Plants using Light games these

cost and maintenance. Two stations of about 15 acres each and one of 68 acres have been installed at the fullmen station for recording runoff and soil losses. Hand sampling has been used to determine the soil content of the runoff water. An attempt has been made to develop a simple aliquot sampler for use on such installations. The tests were conducted on a device for taking an aliquot out of the side of the flume at a point 1/3 of the distance from the upper end to the throat.

The first tests were made using 1/4 inch holes through a plate set in the side of the flume and allowing the plate to project into the flume about one-half inch. It was found, however, that the flow was practically the same with the plate flush with the side of the flume and all future tests were made with the plate flush. Various trash deflectors were tried and a screen was finally decided on as being most satisfactory. With the 1/4 inch holes there was considerable variation in the aliquot for heads below about .35 feet and in order to overcome this objection further tests were conducted using 3/16 inch heles. A six-inch tershall flure was used in the tests as facilities were not available for conducting tests with the larger flumes. It is believed the same device would work on a larger flume and would give, for example, approxim tely 1/4 the eliquot for the two-foot flume as compared to the six-inch flume. The aliquot using 3/16 inch holes would be fairly constant for herds above about .18 feet but the aliquot would be larger for heads from .04 to .18 feet. The flow is low, however, for the lower heads and during periods of considerable runoff it is believed the per cent error would be very small. An automatic gate at the bottom

1,275

the first led at the bullman station for recording runoff and to lesses. Hand eampling has been used to detarmine the noil content of

and to Ell an aliquet out of the side of the flume at a point 1/3 of the

and the second s

If there tests were made using 1/4 tree holes through a plate set he side of the flume and allowing the plate to project into the flume of the side of the flume and all future that the flume and all future the made with the plate flush. Verious tresh deflectors were tried ones a finally decided on as being most setisfactory. With the made there was considerable verified in the aliquet for heads the about .35 feet and is order to everence the objection further tests conducted using 3/16 inch heles. A six-inch sarshall flush was used the tests as facilities were not crailable for excluditing tests with the lumes. It is believed the same device would work on a larger flume lumes. It is believed the same device would work on a larger flume

.. comprised to the six-inch flume. The sliquot using 3/16 inch holes

(Constant for hands above about .18 feet but the sliquet

would be larger for heads from .04 to .18 feet. The flow is low; however;

terms of the control of the control

ter the state of the bottom automatic gate at the bottom

hole, o erated by a float, could be made to open the hole gradually as the head increased, from an almost closed position at .04 to an open position at .18 feet head. The final tests were as follows:

TEST OF DIVISOR

Holes: 3/16 inches diameter spaced .04, .235, .370, .505, .640, .77, .90, 1.03, and 1.16 feet up from floor of six-inch flume. Holes are 1/3 of distance between upper end and throat of flume. Screens were used over holes to prevent trash from clogging holes.

(1) Head	(2) Flown (on	10(3) oun 5 (4)P	roporti	on
in flume	6" flume	Aliquot (2) 4 (3)	
h feet In i	ignosec. ft, and	800. It. 190 . 19	. 20 30 2 1 4	CHILLIAN GAR LINESPA
.062	•025	.000167	150	Bottom hole flowing
11.094 28 88	ra d0494 (hara-	.000247 grass and	199 30	THE STATE OF STATE
.14	.09	.000309	291	n n n 11
*167 St S.	sist \$12 3/16 a		347	to \$700 that. The
,22	.18	.000402	472	10 00 00
.287	.29	.000722	402	Two holes flowing
.37	•43	•000946	455	Two holes flowing
•54	.78	.00193	404	Four holes flowing
.708	1.19	•00286	416	Five holes flowing
1.104	2.42(est)	•00538	450	Eight holes flowing
	Flow	of Individual Fo	les	

Head in flume	Head on Hole	Flow
(feet)	(feet)	(sec.ft.)
.287	-247	.000506 Bottom hole .04' above floor
	w padedner .335 forest	000596
•540	•500	.000745
.708	hus mikin 668 id cler	.000888 wible during tions of some "
1.104	1.064	•001113
	.052	.000216 Second hole .235' above floor
.375	.140	*000330
	endancy 1.295 to 3/16	000532 are to obegined the sequence
.708	.473	.000678
1.104, 53,0	on the up .869 m side	.000915 mot galler than the mod details
•537	.167	.000365 Third hole .37' above floor
.708	•338	000558
1.104	.734	.000824
•537	•032	.000155 Fourth hole .505' above floor
.708	.203	.000413
1.104 are h	es not ye 599 n an	.000745 to to rest this sivinor on a fire
1:104	•068 •494	.000214 Fifth hole .64' above floor
1.104	-334	.000524 Sixth hole .77° above floor
1.104	.204	.000393 Seventh hole .90' above floor

.000231

Eighth hole 1.03' above floor

.074

1.104

less operated by a float, sould be made to op a the hole gradually as need increased, from an almost closed position at .04 to an open position at .18 feet head. The final tests were ra follows:

RIGHT OF DIVILLA

Holes: 3/16 inches diameter spaced.
.90, 1.03, and 1.16 feet up from Floor of six-luch Thurs. Holes are 1/3 of distance between upper end and threat of Flume. Screens were used over holes to prevent trash from clopping holes.

	10-11-24 T # /	Small L	mil ())	· · · · · · · · · · · · · · · · · · ·
		, FT , 100	437. 134	J e
Bottom hile flowing	150	V. 1	ند	5.304
50 29 15	198	.000847	r a	Sec. Sec.
59 19 19	291	. 000000		A
62 50 55	347	.000346	11.	7 1 4
		1	. 17	TI.
Two holes flowing	20%	\$27000.	. 20	~3f.
Two holes Clowing	455	.000046	5 S.	ī, ′ _{\$\$\text{\$\ext{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\text{\$\ext{\$\text{\$\text{\$\ext{\$\ext{\$\text{\$\ext{\$\text{\$\exititt{\$\ext{\$\ext{\$\ext{\$\exititt{\$\ext{\$\ext{\$\ext{\$\exititt{\$\exititt{\$\exititt{\$\ext{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exitititt{\$\exititt{\$\exititit{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\exititt{\$\e}
Four boles flowing	404	.00193	. <	5 m
Five holes flowing	416	8800.	WELE	000
naiwell select fire	10.00		1. 15,1	

	*					100.7	K IT	()
						Latines).	1/10/1	Pern
	. 2	evods	,	,	100/1/100	100 mm	*1	77-3
						430000	4	100
	50	41	9.0	61		10/1/00/01	ann.	C's
						77 0300 a	,	.Vc
	48	4-9	30	0.2		TREESE.	·	
20	flo	avode	.235\$	hole	second	14 E 00 a	2002.	VIII &
	80	41	11	- 80		0573000	907.	***************************************
	\$9	et ,	0.7	23	1.0	21.1000.	175.0	11,7 3 4
	00	96	- 61	99	,	210530	* *	2 y ()
		-		13.		exe066.	PAI.	N.L.
20	013	eveds	.375	hole	ber	2 8 P 3 A () 4		21. 4
	92	\$1	30	52			1911 T m	WW.
	50	es	91	69		150000		SOLL
20	flo	avods.	:308.	noie	Fourth	.000155	260.	VII.
	10	88	99	12	95	.000413	808.	
	03	19	91	FS	88	-000745	.599	1. 11 4 5
79	-71	1 4	111		JISTY	187300%	1700	Ø
	90	19	\$3 A 475.000	60	. (.) . (.)	Nusianais	2334	,
	Plo	evods		nole		.000524	.204	50.5
					Seventh	.000393		
23.60	floc	evods	1:0.1	hole	drigit	fescoo.	470.	10° . a 1

The plotted results of the tests are shown in Fig. . The rliquot averages one part in 430 for heads above about .18 feet. There is slight fluctuation in the aliquot but as the head is variable, it is believed this will not be a source of error. The spacing of holes could be changed if it were desired to increase or decrease the aliquot. Tests were made of the flow for individual holes as shown in Table A and Fig. /% and the flow can be calculated for different spacing of holes.

The test installation is shown in Fig. 15 (a) with the divisor in place. In Fig. 15 (b), (c), and (d) are different views of the divisor. The holes were drilled through an 18 gage galvanized plate, using a drill slightly smaller than 3/16 inch and were then reamed to 3/16 inch. This gave smoother, more uniform holes than if a 3/16 inch drill were used. Individual screens were used over each hole as shown in Fig. 15. The screens were made of 8-mesh hardware cloth soldered over # x 2" holes cut in a piece This steel sheet with the screens slides behind guides of galvanized steel. attached to the sheet with the 3/16 inch holes. It can be easily removed for cleaning and by reising and lovering will she roff mut rial which might be in any hole, thus taking rapid clarning possible during times of runoff. ach screen is 7 x 2 inches and sets out 2 inch from the 3/16 inch hole. There was no tendency for the 3/16 inch holes to clog and the screen clogged only slightly on the upstream side and did not affect the flow as determined by a 48 hour test with water carrying a considerable amount of silt and organic material. Mone of the holes were clogged at the end of the 48 hour test. There has not yet been an opportunity to test this divisor on a field

Form The sliquot ont needs shows about all feet. There is slight in the aliquot but as the hoad is writing, it is helieved this sit; the a source of error. The spacing of holes could be changed if it to increase or decrease the aliquot. Tests were cade of the fidual holes as shown in Table A and Fig. A and the flow can deferent spacing of holes.

y smaller than 3/16 inch and were then resmed to 3/16 inch. This empother, were uniform hales than if a 3/16 inch drill were used.

ched to the shirt with the 3/16 inch holes. It can be casily and by rising end lovering will seem off material which might be

screen is { x 2 inches and rets ont } inch 'ron the 3/16 inch hole. .

weeriel. None of the holes were riogred at the end of the 48 hour.





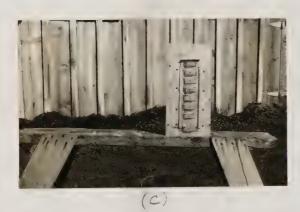
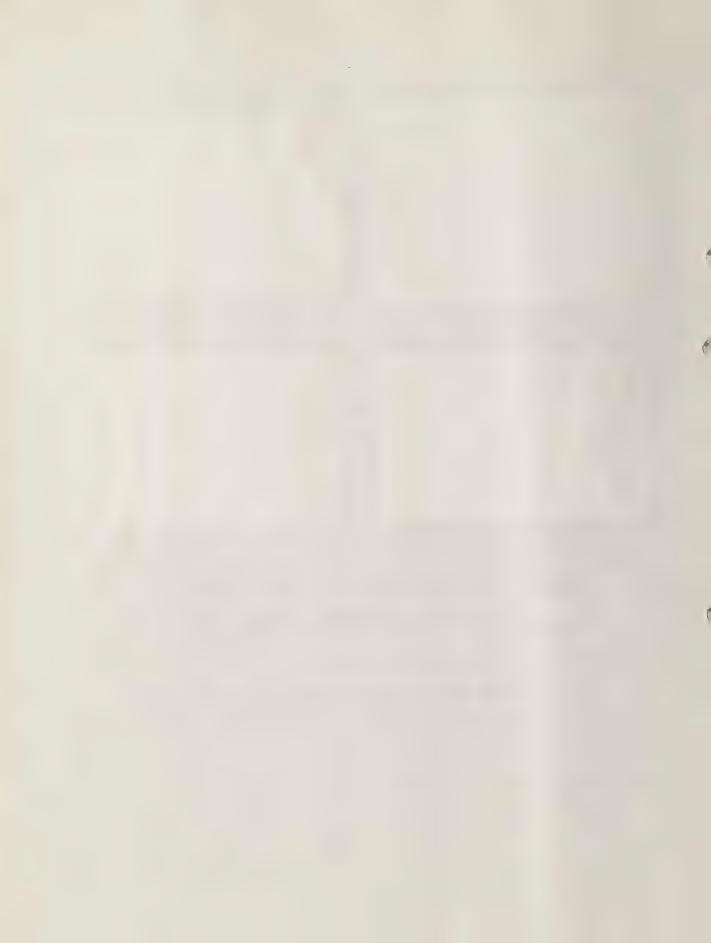


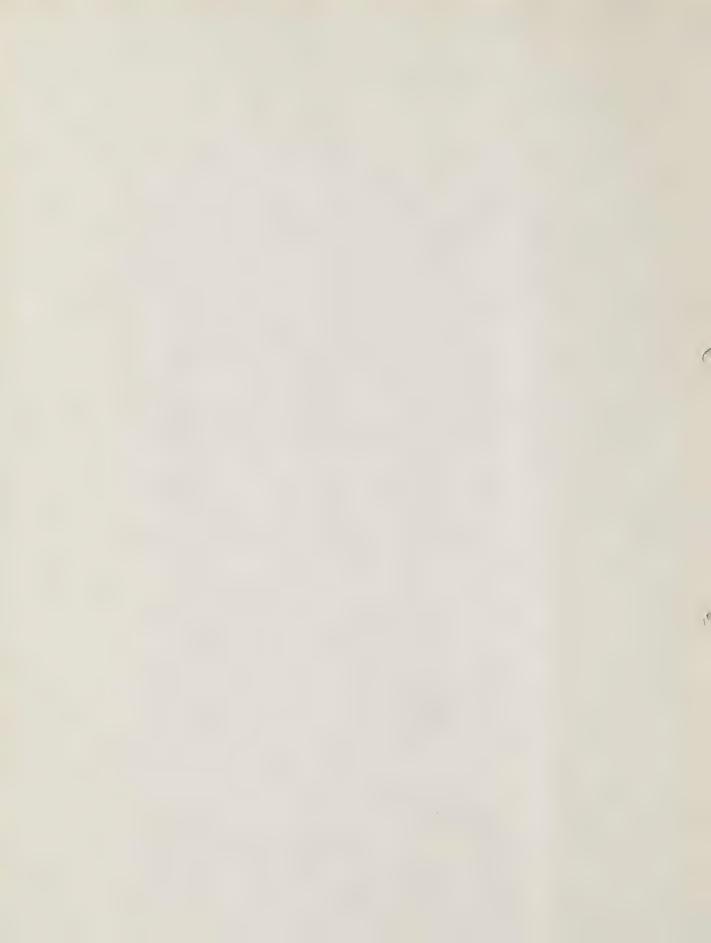


Fig. 15 (a) View of flume with divisor in place.

- (b) Side view of divisor showing well at back for catching flow from 3/16" holes.
- (c) Front view of divisor.
- (d) Divisor with screen recoved. Screen slides behind guides and is easily removed.



Depth in Flums, Feet Point Poi	## Alliquat, I part in ## ## ## ## ## ## ## ## ## ## ## ## ##	Head on Hole, feet 16 18 10 1/2 1/4 1/6 1/6 1/2 1/4 1/6 1/4 1/4 1/6 1/4 1/4 1/4 1/4 1/4 1/4 1/4 1/4 1/4 1/4
	Flow from Hole, sec. ft.	



installation. The water from the 3/16 inch holes is collected in a well attached behind the holes and is conducted to a sample tank of the required capacity. With the spacing of holes used in the tests the aliquot for different size flumes would be approximately as follows: 6-inch flume 1:430, 12-inch flume 1:860, 24-inch flume 1:1720, 48-inch flume 1:3440.

No tests were made of the effect of the divisor on the capacity of the flume. Fractically no eddies are formed, however, and from observation it would appear that the divisor does not effect the capacity of the flume. A few tests were made to compare the silt content of the aliquot to that in the flume. In taking samples one sample was taken of the aliquot while a sample was caught simultaneously at the ortlet of the flume.

Date	Head in	Soil in	Location		Ren	arks		
	Flume	Sample						
	feet	lbs./cu.ft.						
Feb. 13 Feb. 13	•58	.90	Divisor	1/4"	holes-	-no s	creen	
Feb. 13	•58	.82	Flume		90	45 "	49	
Feb. 14	994 WA .10 8 5	4 45 was	Divisor	# N	48	# F. S.	01	
Feb. 14	.10	•44	Flume	88	11	10	99	
Feb. 15		•35	Divisor	3/16"	holes-	-meta	1 trash	deflector
Feb. 15	— — — — — — — — — — — — — — — — — — —	.35 .36	Flume		2 10		***	80
Mars 31	•54	.056	Divisor	3/16"	holes-	-with	screen	
Mar. 31	•54	.063	Flume	98	68	58	00	
Mar. 31	.75	.062	Divisor	10	2.5	39	99	
Mar. 31	•75 •75	.060	Flume	19	64	1/8	N	

It was expected that the soil content of the aliquot would be less than the sample from the flume. This is not the case with the tests, however, as the divisor sample is high the same number of times as the flume sample.

These few samples are not considered as conclusive, however, and for best results it is believed the soil content should be checked when there is runoff from field installations.

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nstallation. The water from the 3/16 inch holes is collected in a well attached bohind the holes and is conducted to a sample tork of the required capacity. With the spacing of holes used in the tests the alimet

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No tests were made of the effect of the divisor on the enpacity of

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A few tests were made to sempare the silt content of the aliquet to that in the flume. In taking samples one sample was taken of the aliquet while a sample was cought simultaneously at the ortist of the flume.

	er abr, A	8.1730	Ron		no theo all	ni fica	Head in	9350
V ***	**				•	108./58.15	teel	
	SCFOON	000-	holes-	2/4"	Divisor	00.	38.	Feb. 13
	14	19	81	0.0	Come 1/4	88.	.58	8f . de
	6.6	86	93	90	Divisor	45	.10	Pb. 14
	89	H	33	89	emill	24.	.20	leb. 14
defiect	deart frash	of Baren	hcles-	3/16"	Divicor	.35	400	Pella 15
11	99	11	91	20	FJ	36.	460	ch. 15
		~ ·		FEET A.	world!			3 4
	80	60	99	10	ocurf T	.083	.54	er. 31
	12	07	97	97	Divisor	.062	.75	is . Tal
	80	£3	19	19	emuliT	030.	.75	TE AL

It was expected that the soil content of the aliquet would be less than the sample from the flume. This is not the case with the tests, however, as the divisor sample is high the same number of times as the flume partle. These few samples are not considered as conclusive, however, and for best results it is believed the soil content should be checked when there is runder from field installations.

SUMMARY

Traded for it a fel four

The steeply rolling wheat country known as the Falouse Region has now been in cultivation about fifty years. Fany slopes of fifty per cent are in cultivation and slopes of 25 to 35 per cent are common.

The average yield of wheat is excellent even though nearly all fields now have some low producing areas, where the subsoil his been exposed by crosion.

The average annual rainfall at a cether Bure u station three miles from the Erosion Station is 20.73 inches. The normal for the seven months of Upril to October is 2.22 inches and for the other five months is 12.51 inches.

The erosion occurs during the senson from lovember to harch except for infrequent summer rains of high intensity. Such survey rains
have occurred at several points during the last three years but are
believed to be of minor in ortance as command to winter erosion problems.

In December 1933, there was rain every day but one for the 18 days from December 5 to 22, the total being 7.53 inches, and on the last day of this period a rain of .79 inches fell with the highest intensity so for recorded for the Station. There was serious erosion on several days during this period and especially on December 23. The maximum rate of rainfall so far recorded was .72 inches for hour for a five rimite period and .30 inches for hour for a 30 minute period.

Experimental terraces were constructed on slopes of from 12 to 32

The cropping system of wheat-summer fallow is rost widely used in the falouse Region and was adopted for the terraced land.

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The average yield of exect is excellent over though nearly all

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at of if many to supply on borner, noted on alopes of from 12 to 32

Graded terraces 780 feet long with vertical spacines from 15 to 35 feet were constructed on land slopes of 20 to 28 per cent. The 35 foot vertical spacing was too great and an intermediate terrace was built. Soil and slope differences caused granter differences in erosion for this experiment than the variation in vertical spacing. The annual soil losses varied from 1.82 to 5.11 tons per acre. The soil loss was 16 to 200 times greater for the winter ceaser following the planting of wheat on survey fallow as compared to land cover d by wheat stubble during the winter season.

Soil losses were measured for graded terraces with 15 feet vertical spacing, grades of 12 inches per 100 feet, and lengths of 400, 780 and 2274 feet. The average annual seil loss v s 1.87 tons per acre for a terrace 400 feet long, 1.82 tons for a 780 feet terrace, and 3.94 tons for a 2274 foot terrace.

Graded terraces 780 feet long and with a fall of 12 inches; er 100 feet had average annual soil losses of .57 tons per acre for a 14.5 per cent slope, 1.82 tons for a 20.0 er cent slope, 7.26 tons for a 23.5 per cent slope, and 5.11 tons for a 27.6 per cent slope. The apparent inconsistency of the latter two is believed to be due to soil conditions. In general, however, the soil loss increases as the slope increases.

Prosion and rumoff were resured for terraces with grades of level, 6, 12, 18, and 24 inches fell for 100 fe t. The soil loss was 1.26 tens or ecre for the level terrace, 2.90 tens for a grade of 6 inches per 100 feet, 7.20 tens for a 12 inch grade, 10.36 tens for an

Traded termines 780 feet long with vertical military Cross 15 is 25 feet term could not review to 25 feet 25 per cewis. The 35 foot vertical specify was too prost and an interministe termine in 11 is a single differences ecual prestor differences in osion for time experiment them the vertication in vertical approximations of the could from 1.88 to 5.11 tons per sone. The same as at 10 to 200 times prestor for the rinter seeson following on the cover 3 by a time of which of which cover 3 by

Soil losmes mereneral for graded beminist little likels werkierl synch gy emilia of 10 inches ser 100 fort, and lengths of 400,

as term of 400 fest lam, 1.85 tons for a 780 foot torrace, and 3.94 ons for a 2874 fout termsee.

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remonf were necessarily for to mades with predes of

10, 18, and 24 inches felt for 100 feet. The soil loss was

1 or core for the level termace, 2.90 tone for a grade of 6

1.00 tons for a 12 inch erade, 10.36 tone for an

18 inch grade, and 13.67 tens for a 24 inch grade. The 6 and 12 inch grades gave best results from the stand oints of operation and soil losses.

Isvel terraces with closed ends impounded water continuously for four and one-half menths and did not have capacity to hold all the runoff. Provision should be made to waste the excess runoff either by a suitable outlet ditch or by tile drainage.

an average of 1.7 inches by somer tillage of fillow land and terraces on land slopes more than 10.0 per cent were lowered an average of 2.9 inches. Terraces should be raintained by making one or two trips along the upper side each season the land is tilled.

The tillage machinery used in the region cannot correct successfully across terraces on step slopes. Best results were obtained by
operating parallel to the terraces and using rachinery which can be
operated in either direction along a slope.

along 8 profile lines and these resurements will be rejected the fell of 1934 and at later intervals to study the rate of soil movement for terraced and unterraced land.

The average annual soil loss from two unterraced watersheds was 16.8 tons per acre as compared to an average of 3.20 tons for representative terraces.

Check daws were built in terrace outlet ditches after which the

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operated in oither direction along a slope.

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of 1934 and at later intervals to study the rate of suil reverent fer

The average unnual soil loss from two unterwood materials ass

. Check damm were b. ilt in terrace outlot ditches after which the

ditches were seeded to a sod-forming grass.

Observations were made of erecipe, and crop yields were taken on land fallowed with the mold board plow as compared to disked fallow; the stubble being burned for part of each condition. The erosion was less where the disk was used and the stubble not burned. There was no significant difference in the crop yields.

Grass seeding on an area subject to wind prosion was started at Cunningher, Enshington. / repuss completed of the tract at Cunningher.

COURT STATE OF LOW REAL PROPERTY.

TABLE NO. [O. EROSION AND RUN-OFF FROM GRADED TERRACES WITH DIFFERENT VERTICAL SPACING

		arimo R	stos of	Rainfe	11	Total	TO A PORT OF THE PROPERTY OF T	A STATE OF THE STA	Vert	mm Rate	on of I	hin-off	De tra ser les tra	MANUSCHICK SAM	Secretary of the second	Total	hun-off		80	1 Loss	e For I	io T	
Date	Min.	10 Vin.	15 Min.	20 Win.		Rain- fall	100	rrace le. 3	The second secon	rrace o. 34	The state of the s	rrano o. L		rrace o. 5	Zor.	Tor.	Ter.	Ter. 5	Ter.	fer.	Tor.	Tor.	Romerte
1933	inches	inches	The state of the s	THE RESERVE OF THE PARTY OF THE	Inches	COLUMN TO SERVICE AND ADDRESS OF THE PARTY O	Sept.	inshes per hr	ALC: NO DESCRIPTION OF THE PARTY NAMED IN	inches per hr	THE RESIDENCE OF THE PARTY OF T	inches per hr	Mary and the state of the latest and	inches per hr	and the same applied to be a second	inches	inches	inches	tons	tons	Tema	Lone	
January 1	.12	.12 .16	.12 .16	.12 .12		.10 ¹ .07 .55 .26	.018 .013	0	.038 .07 .024 .013	.036 .067 .023	.008 .015 .015	-G0 <u>L</u>	0 0 •013 •013	0 0 •010	0 #05 #06 0	-28 -59 -17 -14 -01	.02 .03 .03	.02 .07 .01	0 0002 0002	.019 -040 -023 -019	0	0 0 -00h -001	Ground cover wheat at
Pebruary 21 22 23	.12	.09	, ₆ 08	-07	.07	.22 .661	0 +07 0	0 2057	.001 .038 .008	.001 .036 .008	.10 .08 .14	0 .05h .043	0 ,18 0	0 -112 0	.17 0	_01 .21 _01	.57 .14	710 0	0 .005	009	.015 .004	0 009 0	
Warch 1 2 " 3	.24	. 20	20	.18		.30 0	.058 .06 .013	and deposit the same of the same of	.024 .004	.012	.09 .008	.00/1 :0/16 :0.12	.008 .013 .015	-010	.11 .06 .02	.20 .06 .05	.27 .08 .01	.05 .06 .02	.009 .005 .002	.059	.00ž	.005 .005 .005	
			A STATE OF THE STA		The State of the S	January in 4 to (March 3							- PANERSON AND S	THE PROPERTY OF STREET AND ADDRESS.	1.15] ,61]	.029	.511	•067	-027	
October 29		· 文学 / 文学 / 文学 /	30000000000000000000000000000000000000	Miles Bridge	A Minimum Miles	0	0	0			1 0	0	0		Ho Run	m-orr		0 1	101	.004	0	0	Whiter Theat
November 2 December 6	.50 841 842 844	.24 .36 .36	.22 .28 .32	.20 .था .था	.18 .22 .18	,91 ,50 1.82	.058 .15 .38	.031 .122 .309	.058 .16 .28	.267	0 .046 +51		0 0 -16	0 0 .126	.05 .12 .46	10 -38 -64	0 .02 .19	.06 .15	-068 -102	-039	0 ,021 -286	.0/12 .0/12	
9 10 11 12	.21 .12 .20	.18 .09 .12	.16 .08 .12	.18 .08 .12	-18 -08 -10	.20 1.55 .31 .16	.031 .12 .11 .051	.098 .089 .025	09 •09 •08 •031 •031	.086 .076 .050	.012 .14 .018	.064 .075 .016	.06 .05 .001	Service Page 17 12 17 17 17 17 17 17 17 17 17 17 17 17 17	.04 .05 .05 .07	.18 .07	.02 .53 .25 .02	.01	.925 .134 .002	080	=00/r	.023 .025	
- " 12 15 16	-15	.12	.08	.08	.06	.17 .13 .10	.038 .22 .05	-051 -179 -014	.031 ,11 ,038	.105	.02h .19 .0h6	-,102	0 .05 .008	0 (0.5 (006	.05 .07 .04	.02 .05	•03 •04 •0€	.03 .02	.004 .125 .035	.012		0 028 008	
18	.18	.ie	.10 .03	10 03	.10 .02	65 13 25 18	.07 .07	.057 .057	.05k	051	.08 .06	.015 .032	.016 .016 .026	-01/r	10	38 16	1.00	-10	.122 .061	.061	.072	021	
20 21 22 23 25 26	.7E	.20 .42	.18 .25	.18 .21	.16 .19	.18 .79 0 0	.05 .26 .56 .58	-014 -226 -471 -309	.038 .18 .45 .26 .004	.056 .172 .410 .218	.06 .74 .5 .8 .8	.032 .182 .211 .155	.160 .230 .180	126	15.447.50	-17 -15 -57 -21 -10	-04 75 -10 -10	-04 -06 -33 -03 -0	.230 1.210 .299	.061 .050 1-122 1/71 022	.158	.102 .1176 .064	
<u>" \$ A</u>		THE THE STATE OF		The same of	The second second	(601	0		.001	-001		0	0		0	124		Q.	0	l ,oil.	0	ŏ	
				The state of the state of	The state of the s	ontober al for 1	All the second sections and the second	to Desemble 1955							THE PERSON NAMED IN	and makes and and an arrangement of	- Control of the cont		4.533 4.542				
			Salah Salah Salah					Action to the second		AND THE RESERVE OF THE PARTY OF			A STATE OF THE STA			inglished and	The state of the s	Salah Car	Section of the sectio	Contractors of the Contractors o	TO THE STATE OF TH		

Torrace No.	Drainage Area	Land alope	Vertical Specing	Langua	t) rede
A CONTROL OF THE PARTY OF THE P	Aorea	per cont		feet	Inches per 100 feet
3.	1.22	27.0	20.0	780	
3.4	1.04	27.6	15.0	780	12
	1,05	25.6	25.0	780	12
5	1,26	20,0	15.0	790	the state of the s

1. Page



TABLE NO. ||. EROSION AND RUN-OFF FROM GRADED TERRACES OF DIPPERENT LENGTHS

Date		M	aximus R	ates of	Rainfal	11	Total	A CONTRACTOR OF THE PARTY OF TH	Varie	a Rati	of R	m-off	Section of the second	To	tal Bun	-off	3011	Loss ;	per Asre	Ronnrks
The Manual State		5 Vin.	10 Min.	15 Min.	20 Min.	30 Min.	Rain- fall		T800	100	race		rrane o, 6	fer. 2	Ter,	Tor.	Ter. 2	Ter.	Ter,	
1933			inches per hr			inches per hr			inohes ber hr		inches per hr		inches per hr	inches	1nches	inohes	tons	tons	tons	The State of the S
James	L 578	.12 .16	.12 .16	.12 .16	.12 .12	.12 -08	.10 ¹ .07 .55 26	.002 .028 .007	.050 .012 .004	0 - -013 -013	0 .010 .010	.12 .10 .08 .03	.025 .021 .017	.03 .22 -12 .01	0 .02 .07 .01	.14 .21 .18 .07	.001 .008 .005	0 •001 •001	.003 .004 .006	Ground cover of winter wheat stubble
February "	9 21 22 23 26 28	.12	. 09	.08	₃07	.07	.08 .22 .661 0	0 •001 •016 0 0 •013	0 .001 .028 0 0	0 0 .18 0	0 0 .11/2 0 0	.05 .01 .20 .03 .03	.006 .002 .042 .006 .006	0 .02 .25 0 0	0000	.01 .05 .26 .02 .01	0 0 .005 0 0 .001	0 .009 0 0	.001 0 .005 0	
March " " "	12345	.원	-20	.20	.18	"1 6	.30 0 0 0	.007 .016 .002 0	.012 .028 .00\; 0	.008 .013 .013 0	.006 .010 .010 0	.10 .40 .16 .04	.021 .085 .034 .008	.05 .05 .03 0	.03 .06 .02 0	.15 .29 .20 .04	.007 .007 .003	.003 .005 .005 0	.004 .008 .005 .003	***************************************
	7 8 -12						•25 ¹ 0 •37 ¹	0 0	000	0 0 0	0 0 0	.02 .04 .03	.00/4 .008 .006	0	0	.02 .03 .05	0 0	0 0	.001 .002 .012	
	\$530, 55 30s	A LOUIS ROOM				otal J			1.1866		THE STATE OF THE S			. 84	.61	1.77	.037	.027	.058	where the parties with the second section of the
The state of the s				THE PARTY OF		The state of the s	15 to			Name of Street				No Ru	i-of T	distanta di Para		A Charles		was the first service and control of the control of
November	9 10 11	.20 .12 .18 .18	.36 .36 .18 .09	.28 .32 .18 .08 .12	.27 .21 .18 .08	.22 .16 .18 .08	.50 1.82 1.55 .31 .16	.020 .037 .037 .037 .004	.066 .066 .066	-16 -06 -05 -004	.126 .047 .043	.06 .49 .95 .23	.013 .104 .201 .049	.04 .15 .48 .09	.06 .15 .33 .04	.01 .25 ² .80 ³ .10	.009 .212 .234 .043	.042 .222 .191 .023		Winter wheat on summer fallow
	12 13 14 18 19	.12 .18	.12 .12 .03	.08 .10	.08 .10 .62	.06 .10	.17 .13 .10 .65	.010 .037 .016 .028	.066	0 -05 -008 -018	-014	.04 .12 .12	0 .030 .008 .025	.02 .03 .04 .35	0 .03 .02 .10	0 .03 .02 .08	.004 .024 .016 .038 .068	0 .028 .008 .021	0 .028 .006 .021	
	19 20 21 22 23	.a. .72	.20 .42	.18 .28	.18 .21	.16 .1 4	.25 .18 .79	.033 .095 .222 .162	.058 .168 .393 .287	.02h .16 .23 .18	.019 .126 .181 .1h2	16 以 以 28	.034 .114 .114 .059	.21 .07 .55 .08	•0h •06 •33 •03	.04 .39 .03	.233 .078 .842 .192	.013 .102 .476 .064	.013 .102 .l ₁ 76 .06l ₁	** ** **
	CONTRACTOR				7	Cotal No			the same of the latest and the lates	r 31		NO.		2.40	1.24	1.90	2,002	1.203	2.065	The second appears of the contract of the contract
						TOCHT	for Ye	at 1A)						CHICAGO CONTRACTOR	1.85 L Sno	MANUFACTURE SOL	2.039	1,250	2-123	Commission of the weather the

Terrace No.	Drainage Area	Land Slope	Vertical Spacing	Longth	Grade
	ACres	per cent	fast	feet	inches per 100 feet
5	1.26	22.6	15.0 15.0	780	12 12
	4,68	16.2	14.7	2274	12

2. Squirrel hole under terrace 1500 feet from outlet was plugged 9:30 A.M.

plugged 9:30 A.M.

3. Squirrel hole under terrace 300 feet from outlet plugged 10:30 A.M.



TABLE NO. 12. EROSION AND RUN-OFF FROM GRADED TERRACES ON DIFFERENT LAND SLOPES

A significant and the second second	A STANDARD AND AND AND AND AND AND AND AND AND AN										the supplication of the su							gay, y knowking of L					
	Ma	ziman R	ttes of	Rainfal	1	Total			Marda	nım Rate	n of F	nm-off				20tal		Jo l	l Lann	and the second s			
Dato	5 1/1n.	10 Min.	15 Min,	20 Min,	30 Min.	Rain-	170 (9)	race	100000	race		race		rrae . 3A	Ter.	1.r. 5	Ter. 17	Tor.	Ter. 7	for. 5	Ter. 17	Ter, 34	R
1.953	inches	inches	inches	inches	Inches	inches	850.	Inches	880.	Inches	500,	inches	Sec.	inches	inches	inches	inohou	inches	tons	tans	tuns	Tools	The second second
AND STATE OF	per hr	4444	per hr			A CONTRACTOR	foot	por hr	feet	per hr	A LONG BUILDING STREET	par hr		per hr							NAME.	l ara	Ground nove
January L						.10 ¹	.08	ە350	0	0	*00F	.00L	.038	.056 .067	-28 -86	105	.02	-28 -59	200.	0	.001	-019 -040	Wheat
" 3						.07	.29	.018	ō	-	0	0		6	18	0	0	6	.001	ō	0	0	
7	-12	.12	.12	-12	-12	•55 •26	,29	.138	.013	.010	-001	-001	.024	-023	1,15	.07	.05	.17 .14	*050	-colt	-005	.025	
<u> </u>	.16	-16	.16	.12	-08		175	.057	-015	.010	0	0_	_015	012	1.73_	.01	2		.015	_001	0	-019	1 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
February 21						00.0	.018	.009		0		0	.008	.008	150	ő	0	-01	0	0	0	.019	
February 21 22 25	.12	.09	.08	.07	.07		80.	-038	.18	-142	_00L	_ogl	058	036		-710	-05	-21	007	.009	.003	.009	
· · · · · · · · · · · · · · · · · · ·					1	.22 .661	.008	*004	0	0	0	0	p008	.008	.28 .02		0	-01	0	10		0_	
March 1	a		11/2 to 1	70	1000	0	-018	.009	.008	-006 010	100	*DOL	-02L	023	a06	.03	-02	≥20 ≥06	-001	.003	007	.205 .116	
P. 7	,21	.20	.20	18	-16	.30	.25	.119 .038	.015	.010	001	.001	.013 .004	.00L	-18 -14	-06	-01	203	_001	005	1 6	059	
7						251	013	006	0	0	ō	ō	0	0	.01	0	Ō	ō		0	0	ō	<u>. 1</u>
7 6	in.					0,	.06	.028	0	0	0	0	0	0	408	0	0	0	-001	9	9	0	
No.						0.3/1	*06F	.011	0	0	0	0	0	9	-03	9	9	0	-005	0	- 1	0	in the second
10-11	运车 署	W. Barrier			The State of the S	Wasan Salah	-05	•026		п0	阿拉克米里			CAN I				The state of the s	A RENTHERMOND	King garage		1 12 13 808 18	
	The second of th							March 1							4.25	-61	1.25	1-71	.059	+027	*018	251	
					Mara	h 12 to	Octo	ber 28				No Thin-off									A PARTY		
October 29	The state of the		Top being the T			0	0	0	0	0	0	0		10 M	0	0	0	-01	0	0	0	-004	Time the last
3	-36	<u>.</u> 얼(.22 .22	.21 .20	ló	1.73	0	0	0	0			1 .0		9	0	16		0	0	-014 -216	0	5-11-0w
November	.36 .30 .48	.원 원 36	.28	27	.16 .18 .22	•73 •91 •50	0 0 0	"			.06 -15	.065 -162	.039 .16	.036 .153	1 %	_06	28.	-10	0	_0.2	378	.039 .220	
December 6	1.8	36	.32	21	.18	1,82	0	ō	-16	126	18	.517	,28	267	<u> </u>	.06 ,15	62	- 36 - 64	ō	22	2 275	1.087	6 20 C 3 5 T
$\overline{1}$	1					0	_0	.9,	-0	0_	.013	*014	0	0	_02	22	06ء	0	0	0	240	0	
., 20	,21 ,12	-18	.18	.18 .08	-18	1.55	.14 .02h	.066	-06	-047 -043	.09 .08	-097 -086	-09 -08	.086 .076	.02	5	.85 .20	-87	.009	122	1-550	.951 .197	37/14
n	.20	.09	.08 .12	.12	.08 .10	-31 -16	0	0	.05 .004	003	.031	033	.031	.030	0	,04 ,01 0	605	•18 •07 •02	0	005	.366 .062	-000	
" 12	A SECTION AND A SECTION AND ASSESSMENT OF THE PERSON ASSESSMENT OF THE PERSON AND ASSESSMENT OF THE PERSON ASSESSMENT OF THE PE				State Land	17	0_	0_	0	<u> </u>	ody6	050	.051 .051				.05 .06	-03	0_	1 0	-016	-009	\$ 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1
			man de Sina de			.13 .10 .65	0	0	e05 e008	, OL3	1.15	.162	1-11	-105	9	100	-06	.05 .05 .38 .16	9	.028	,1 1/2		
" 18	.12	-12	.08	-08 -10	.06 .10	-45	0 .031	0 0015	-018	-006	.051	•033 •065	-038 -054	.036	_01.	- U2 - 10	-09 -2h	1 -05	0 005	800. ISO.	.020		
	.05	.03	03	.03	-02	113	.031	.015	.015		.018	.019	.030	.036	-04 20.	l ali	100	16	_601	006			
" 19 " 20 " 21	With the same of		He Constant		1 - Whi - 3 -	.13 .25	.031 .024	.011	1057	.019	038	-001	035	.036	+02	.02 .10 .di	-05		.001		,022	1-04	
	.2h .72	.20	.18 .28	.16 .21	.16 .1#	18	.12 .16	.057	16	.126	-018	.019	#18 #13 #26	-172	.03 .2h .01	.06 33 .03	.06 .03 .24 .10 .05 .03	.13 .57 .21 .10	.009	102			
# 53 # 53 **	Me	#2	660	1 054		.79	-06	.076	.23 .18	.181 .142	.58 .J.1	1525 1534	26	راراً. 10ءاء	01	03		.21	350 Jack	*0G		1.122	***
• 2						5714555		0	0	0	0	0	"COT	JOOL L	0	1 6	0	_10	i i	0		022	
" 25- 31	lank i prik	AND THE REST	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			.60 ¹		0	0	0	0	0	.001	.001	0		0	<u> </u>				,01 <u>L</u>	
				Wales - Alleg		Charles Transport Street	more salisation that	Decemb	or 1	A A STATE OF THE STATE OF	A STATE OF THE STA	Same and the		The state of the s	1.12	11,41	<u></u> ≥178	14165	The second second	a constitution of the cons	S DESCRIPTION OF THE PARTY OF T		
	Latin 15 15				Tota	l for l		933	THE PARTY OF THE P	Charles Andrews	A service and the service and	edir odlykalyte. Stanion od postal			4-51	p. 85	15.95	5.94	- 54	1.230	18-01	5,000	
Torrace No.	The D	ralinago	Area		J Lope	Mary Mary	(Traile	l Space	n	Long		Orade	PER VENEY E		(2000年)								
+ I SAME THE	Marin	Acre			cant		A PROPERTY OF THE PARTY OF THE	feet		101			per 1	XI Post	A STATE OF THE STA		Snew						
\mathcal{J}		2.09		177.00	4.5	W I		15.0			30 an	12					Value 1			es dom	and a feet of	T Trom	
		1.26			10 ₀ 0			15.0 14.2		7	80 80	12 12					Terrace Squirrel						
3 <u>1</u>		1,04			7.6			15.0			30	12				The second	\$ 9130			M fuet	Single Spin		
A CONTRACTOR OF THE PROPERTY O		A SPACE OF THE PARTY OF THE PAR						337.00				The Marie Co.		13 4 3				15 My 1 1 19	LINE STORY	- 12 Ball		新かまかまとうべ	



TABLE NO. 13. EXOSION AND EUROSF FROM TERRACES
WITH DIFFERENT GRADES

			The state of the s			The state of the s		The state of the s	The state of	1 To 16 18								The state of the state of	The same of	4 37 - 44 507							
The state of		planteur.	Onter (of Hain	en -	Tota		en e				inter of Run-eff			The second second		APP TO THE REPORT OF THE PERSON OF THE PERSO	Total Bun-off			1	Eoil Le		Loss For Asra		Strate Strate	Marian Balance
The state of the s	у Ина	ULn.	Vin.	20 Wh.	30 Min.	Kain fall		0:140e		errace No.18		rrneo lo.17		1700 0.16		irraeo la.15	Ter.	7er. 13	17	Tor.	167. 15		Ter.	17°	ler. 16	70r. 15	Results
1005		lumben	Inches	Acehes	inches	AFRICA THE	800.	Inches	nou.	Imahaa	000	Anches	in introductive fall	inches	The same of the same	Inches	A STATE OF THE PARTY OF THE PAR	The state of the s	Inches	THE RESERVE TO SERVE THE PARTY.	THE RESERVE OF THE PERSON NAMED IN	19116	tonn	tone	toms	tonn	
Jamery I	per lu	per hr	per m	per nr	per fir	,10 ¹	.ook	Der hr	fost -001	per hr	100t	per lur	foot .038	ocké	feet .07	per hr .075	-02	.01	.02	-34	.eL	0	0	,601	013	.out.	Ground cover
						.07	06	,039 0	_00L	005	,008	.009	0032	.057	.08	.089	114	01	-02	-St	. 64 . 52 . 60 . 71	-002	1001	.001	_013	010	of winter wheat atubbl
	.12 .16	.12 .16	710 715	.12	.08	•55 •26	.001	.001 .001	.00L	.003	001	.001	.018	.089	015	.020	.02	-02	.05	0 ,22 ,18	.a	ŏ	001	2003	0.015	.016 .027	
			100		4444	.08	0	0	0	.001 0	0	0	and the property of	005	800. 800.	.025 0009	.01 0	-01	0	d	-08	0	0	0	.011	-010	
February 2	.12	•09	.08	=07	.07	0 .22 .66	09	0 2	0	0	.ook	*00F	.001 .001 .013	.005	.038	o .de	.02	0 .01	0 •05	05 17	*65 *52	.001	0	0003	.036 .021	.027	-
." 27-21					inelf.	.12	09	.008 0	0	0 .	0	0	0	0	.008 -051	.009 .035	.03 .03	0	0	0	,02 ,12	.001	0	0	0	.005 -013	. 11
Tert of	باعم	.20	.20	.18	.16	0 .30	0 .02/c .11 .05/c	.016 .072	.001	.001 0	.001	,004 ,001	.018	.022 .029	810. 850.	.020 .0µ2	.06 .46 .17	.01	.02 .01	18	,14 -16 -09	+005	S00.	,007	, club,	e17	
7-10			7 7 2		ere ere. 	553	.05L	035	2	Õ	Ö	0	,008 008	010	.008	009	17	0	. 0	.15 .07	.09	051 015	0	.003 0	.038 -017	.020 .015	
						1000	The state of the s	PERMIT						-""				11	0		i i i i i i i i i i i i i i i i i i i	0	2	0	.012	0	
Total January 1 to March 10 Warch 11 to Outsber 28												e and the second second					.93	.07 m-off	.15	1.77	2,52	,079	,ock	.018	.196	-197	
Outober 3						0			0		0	0					.01	0			-01	.001			.010	.004	Winter when
November 2	.30 .30	.원 경 36	22 23 26	.ට න	.16 .18 .22	.75 .91 .50	0 0 20 0	0	.031	.016	ina ina	-054	.015 .05h .15 .00h	.016 1065	800. 30.	.009 .067	0	.01 .05 .08	.01 .16 .28	.00 .07 .85	.05 .17 .10	0	.005 •0bb	.014 218 .378	.036	037	on summer
. 4	1,40	.56	,23	.27	.22	.50	,eo	0 -150 0	112	101	.16	162	- [.181	19	.212	.11	08	-28	-80		010	070	.378	-037 -1717 -037	.014 .041 .786	
December 6	Jes	.36	.52	<u>.</u> ш	.11	1.82	-19	,18,	-31	261	等作量	.517	.006	77.6	, <u>j</u>	,602	, <u>9</u>	-,66	,63 ²	.75	.91	-352	1,080	2,255	2,635	5,688	
9	.21	18	.18 .08	all	16	1.53	19	0 •124	.024 .16	.020 .134	,013	.01L	.05 .05	.010 .075	.00£	.00h	80 ³	-CL	.65° .05 .05	.0L .7L .20	1.00	0 2203	.608	1.550	.052 2,505	2.795	
" 10 " 11 " 12		.09 .12	12	.00	.06 -10	-31 -16	.07 .018	-016 -018	.07 .02	059	.08	.086	•0克 •0旦	065	#008 #013	.009	.142 .032	. <u>H</u>	.02. 80.	.20 08	.15 .08	.0382 .003		.366 .060		2,795 ,420 ,079	
" 12 " 13						.17	.015 .018	.008	0	.08L	.046 .15	.050 .162		_029	.008 .19	-009 -212		0	.05	.10	,11	بالادو	0			-109	1
13 14 15-1	.12	115	.08	a08	.06	.10_	-013	.008	ool.	020	051	055	•14 •036	.169	.001	_001	05	.02 .02	.06 .03	15	.10 .05	.005	*006	.046 .142 .020		310 017	
		.12	.10	.10	-10	50°	.015	.008	.001	_001	o		.001 .00L	.001 .005	The second second		023	0	0	- 연. - 05	135	002	002	<u> </u>	'007i	ر فرو	
19	.03	-05	.03	05	.02	13	.110 .070	.072 .046	.06 .046	050	.05 .018	.065 .019	.058 .051	.046 .057	.059 .016	-060 -051	-582 172	.25 .09	10 10	.29	.61 .26	.050 026	092 038	.150 .01,6		,268 121	
. <u> </u>	.el.	.20 .42	.10 .23	.18 o21	.16 .1#	15 25 20 70	.070 .160 .230 .190	.104 .150	.054 .25	195	.050 :010	.019 .019 .625	,024 11	.169	.006	.051 .009	172 772 152	.09 .07 .14 .57	+10 +05 +05	.20 .64	.26 .16 .8i. .81	.158 018	.090 .129	-022	.161 -181	.073	
* *	T " T	452	,25	- 441	-,14	. 79 0	.190 .150	.104 .150 .194 .095	.25 .31 .25	.099 .065 .193 .283 .193	.059 .016 .58 .L1 0	.625 .334	9 15 15 16 16 16 16 16 16 16 16 16 16 16 16 16	.037 .029 .169 .605 .266 .005	湯	.852 .813	.52 ³	.57 -05	-64 -10	16	.81 .17	,252 052	3,25	3,990	2,990		
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